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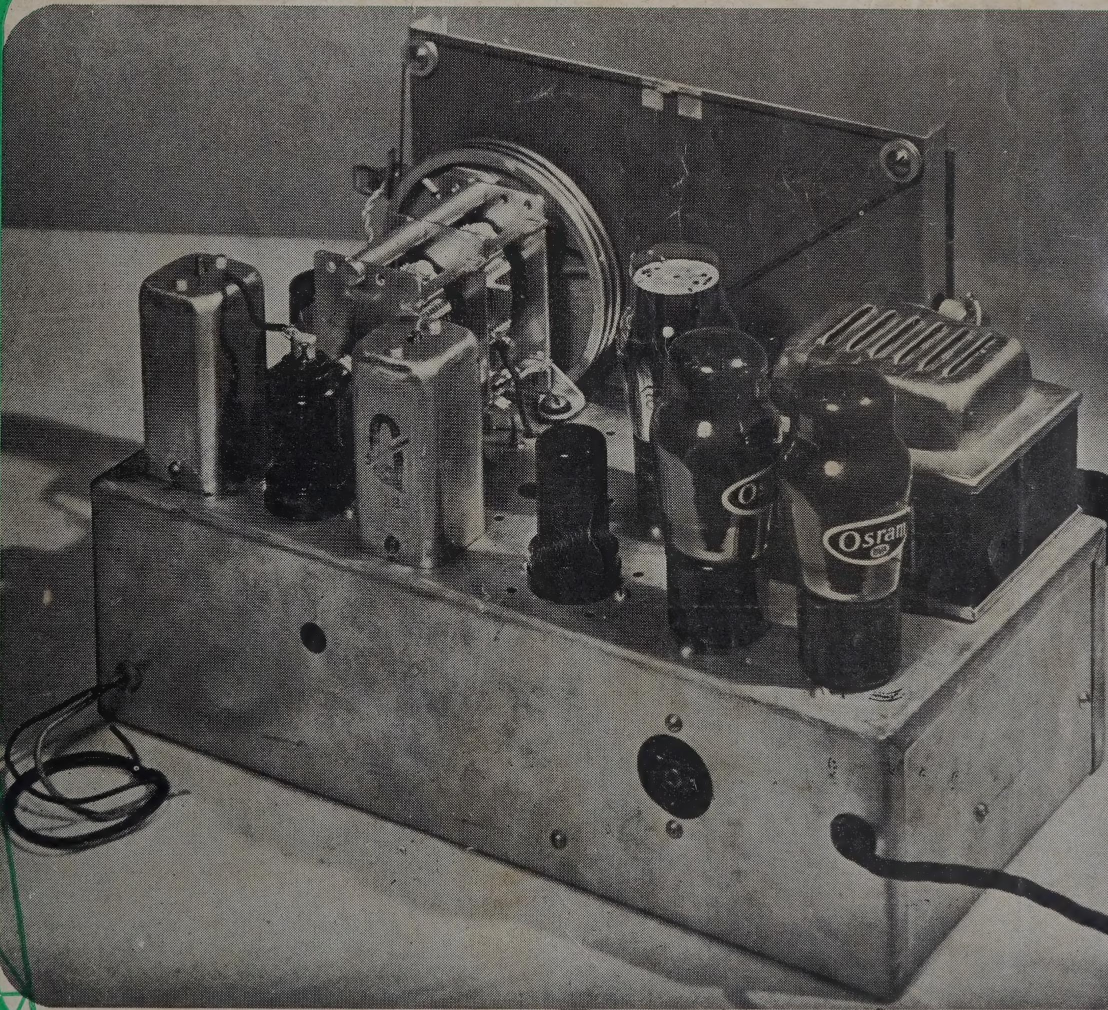

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RADIO and ELECTRONICS

Vol. 2, No. 12 March 1st, 1948

Contents Page

OUR COVER this month shows a general view of the High-quality Dual-wave Receiver described in this issue. (See p. 10.)

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PORTABLES—and all that . . .

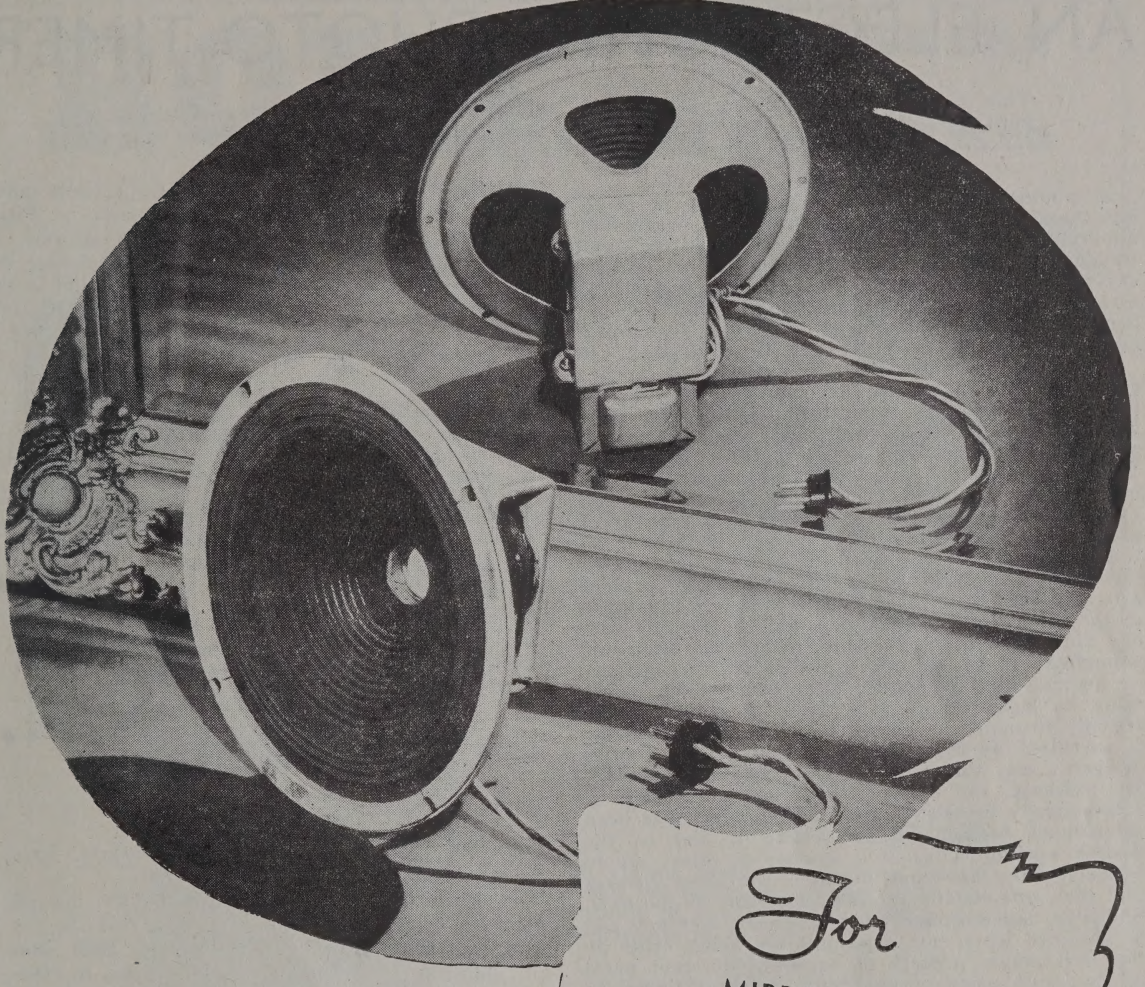
There seems little doubt that the advances made during the late war in the miniaturization of valves and other radio components have stimulated considerable interest in portable receivers. Really small portables can now be made quite easily, and they are finding ready public acceptance, due partly to their novelty value, and partly to their real utility. There seems to be a danger that miniature portables may fall from favour because of uninformed, unfavourable comparison of the midget set with the larger type of portable which is still sold in fairly large numbers.

The latter are not miniature sets in any sense of the word. They employ full-sized components, and the normal GT types of 1.4 volt valve which are used in full-sized battery-operated sets. In addition they have 90 or even 135 volt H.T. batteries. As against these features, the miniature sets use 67.5 or, more often, only 45 volts of H.T. They use miniature tubes, whose performance, though excellent, is not quite up to that of the larger ones. They use miniature I.F. transformers, and their built-in loop aerials are of necessity much smaller than those of the large sets. With all these points working against them, they still have an excellent performance, and yet many complaints are heard, even from those who should know better, that such receivers are "no good."

One common complaint is that "the set is not loud enough" or that "it distorts badly when you turn the volume up." This is simply a lack of realization on the part of the user that a miniature set cannot be reasonably expected to produce anything more than a comparatively miniature amount of sound—that is, unless he wishes to buy new batteries twice as often, or even more, by being provided with a miniature receiver with as much power output as one of the large portables.

Again, we have heard reports of dissatisfaction with miniature sets on the grounds that they will not receive anything more than 2YA in the daytime, when located in New Plymouth! To us, this looks like an obvious case of sending a boy on a man's errand. A midget I.F. transformer cannot be expected to have more than about 60 per cent. of the gain of a full-sized one. The miniature loop, at a conservative estimate, has only half the pick-up of one used in a large portable. The 1.4v. miniature valves have on the average 0.8 times the gain of their larger counterparts. Multiplying all these factors together, it is estimated that the miniature set can be expected to have 20 db. less effective gain than the larger portable set. This represents a very substantial difference in performance—one which can be regarded as the inevitable price to be paid for miniaturization.

The sooner both technicians and the public at large realize that full-sized performance can be expected only from a full-sized receiver, the sooner will the midget portable be appreciated for what it is, so that it can take its rightful place in the set market. If it does not do so, the possibility is that once its novelty value has been exploited, it will cease to have a place at all.



AN ELECTRONIC PHOTO-TIMER

This timer is intended mainly for the automatic timing of printing exposures, either with an enlarger or contact-printing box. It is inexpensive to build, and uses only one valve, apart from the rectifier.

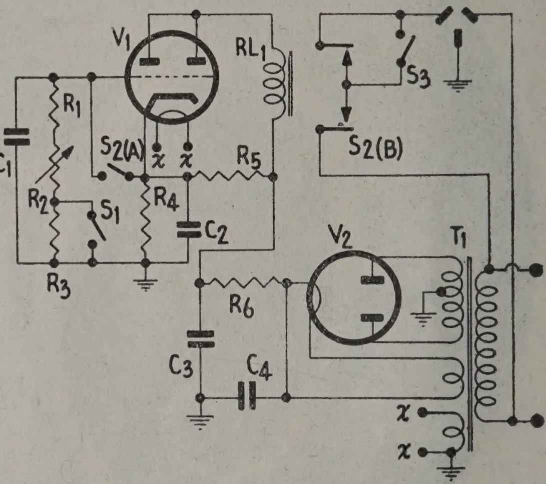
GENERAL

In photographic work, and particularly in printing, the correct timing of exposures is of paramount importance if results generally are to be of the same standard from time to time. It is for this reason that devices which assist the photographer accurately to estimate times are gaining increased recognition as necessary pieces of equipment rather than just useful adjuncts that can be dispensed with if desired.

Operations involving longer times, such as are encountered in the tank development of films or plates, are most conveniently measured and indicated by some kind of clock, and special darkroom clocks are to be found in every dealer's window. However, although timers for automatically determining the length of printing exposures are well enough in principle, and are found in a number of professional darkrooms, there has yet to appear on the market a reasonably priced instrument within the means of the skilled amateur. The present article describes a timer which can be constructed at the outlay of only a few pounds by anyone who has had even a little experience in building electronic equipment. It has a socket, into which the enlarger or printing-box is plugged, and from which it obtains its lamp supply. The latter is connected internally through the contacts of a relay. This relay is energized by the plate current of a timing valve in such a way that when a "start" button is pressed and released, the enlarger lamp comes on, and is automatically turned off after a time which has been determined beforehand by setting a dial to the desired reading. Thus, if a number of prints are to be made from the same negative, the timer ensures that each gets exactly the same exposure as the next. Similarly, much greater than ordinary accuracy can be obtained when test exposures are being made by the well-known process of exposing different parts of the same piece of paper for different times. In addition, the convenience of being able to allow the timer to determine the length of the actual exposure can hardly be over-estimated, as it allows the operator to give his attention to other matters, such as preparing the next negative to be printed, with consequent saving of time.

PRINCIPLE OF OPERATION

As in most other electronic timing devices, the part of the circuit which measures the times consists of a condenser, which may be discharged through a resistor. In the circuit, the timing condenser is C_1, and the resistor is made up of R_1 in series with one or both of R_2 and R_3. The switch, S_1, is to short-circuit the latter when it is not required. The valve, V_1, is a 6N7 with both triodes connected in parallel by strapping the two plates and the two grids together at the socket. It is normally biased beyond cut-off by the voltage divider, R_4 R_5, at the junction of which the cathode is connected. Thus, in the unoperated state, V_1 does not conduct, and the relay RL_1 is de-energized. Now, when S_2, which is a press switch, returning to the open position when the pressure is released, is pushed, the section called S_{2a} on the diagram performs two functions. First, it connects the grid of V_1 directly to cathode, so that it passes heavy current, immediately closing the relay. At the same time, the positive potential at the



COMPONENT LIST

R_1 = 100k. 1 watt.
R_2 = 3 meg. pot.
R_3 = 2.5 megs.
R_4 = 750 ohms 10 watts.
R_5 = 50k. 10 watt adjustable.
R_6 = 7.5k. 25 watt.
C_1 = 4 mfd. 500v. oil-filled.
C_2 = 25 mfd. 25v. electro.
C_3, C_4 = 16 mfd. 500v. electro.
T_1 = 300-0-300v. 60 ma., 5v. 2a., 6.3v. 1a.
RL_1 = relay, 5000 ohm coil, 20 ma. to close.
S_1, S_3 = S.P.S.T. toggle.
S_2 = see text.
V_1 = 6N7.
V_2 = 80.

Note.—Adjust R_5, with S_1 closed and R_2 at max. resistance, until a time of 25 secs. is obtained.

junction of R_4 and R_5 is applied to C_1, which charges up to this potential. Although the resistors are permanently across C_1, this does not matter, as the timing operation does not start until S_2 is released. When this is done, C_1 commences to discharge through R_1 and R_2. After a period of time which is determined by the setting of R_2, the grid voltage of V_1 drops to the cut-off value, when the relay opens, completing the timing operation. It should be noted that the timing starts, not from when S_{2a} is pressed, but from the moment of its release. The interval between the pressing of the button and its release is used to charge the condenser. In practice, the latter charges up very quickly, and the pressing and release can be made as rapidly as desired.

The operation of the relay and of S_{2b} and S_3 remains to be explained. The former operates at the same time as S_{2a}, the two making up a D.P.S.T. unit, in which (a) makes at the same time that (b) breaks. With this in mind, the working of this part of the circuit can be readily seen. S_{2b}, then, is normally closed, and opens when S_2 is pressed, closing again when it is released. Thus, current is normally applied to the relay contacts. Now, it will be remembered that the relay closes AS SOON AS S_2 IS PRESSED, but that the timing does not start until S_2 is released. If S_{2b} were not included, in order to break the A.C. connection at the output plug until such time as S_2 is released, the lamp would light as soon as the latter was pressed, and a variable and indeterminate error would be introduced into the timing. The actual value of this error would be equal to the time during which S_2 remained depressed.

The full sequence of operations can now be briefly outlined.

(1) The dial R_2 is set to the desired exposure time.

(2) S_2 is pressed, upon which V_1 conducts, operating the relay. At the same time, S_{2b} opens, so that, although the relay contact is made, A.C. is not applied to the lamp socket. While S_2 is held down, C_1 charges to the positive potential that is applied at all times to the cathode of V_1.

(3) S_2 is released, closing S_{2b} and lighting the lamp.

(4) At the same moment that the lamp lights, C_1 commences to discharge, and after the predetermined time V_1 releases the relay, which breaks its contact and turns off the lamp.

PURPOSE OF SWITCH S_3

No mention has yet been made of the use of S_3, though this should be fairly obvious from the circuit diagram. Since S_{2b} is normally closed, A.C. is normally applied to S_3, which is connected across the relay contacts. Thus, when the timer is not actually in use, the lamp can be turned on for focusing purposes by closing S_3. Then, when the timer is to be used to make the exposure, S_3 is first opened, extinguishing the light and placing the timer in control. By this means, it is rendered unnecessary to unplug the enlarger from the timer in order to have the light on indefinitely for focusing.

USE OF S_1

The range of times most useful for printing work is one from 60 seconds or more. This range could be provided by using a single resistor, R_2, if this were properly chosen, but if this were done, it would be found that the scale would be far too cramped at the shorter times to make the setting of the dial sufficiently accurate. For this reason, the timer has been provided with two scales, one covering one to 30 seconds, and the other 20 to 60 seconds. It will be noticed that there is a generous overlap between ranges. This has the desirable effect of greatly reducing the number of times at which it is necessary to switch from one range to the other. For example, if one is working from short to medium times, the low range can be used almost exclusively, and similarly with the high range, if the required times vary from medium to long. When S_1 is closed, only R_2 is in circuit, and the timer is on the short range, while when it is open, R_3 and R_2 are in series, giving the long range.

POWER SUPPLY

This is quite conventional, and uses an 80 and a 385 v.-a-side transformer. It might have been possible to use raw A.C. for the H.T. supply, but the idea was discarded on account of the possibility of inaccuracies appearing, due to the indefinite charging voltage that A.C. would provide. A great deal of smoothing is not required, so that resistance-capacity network provides all that is necessary.

CONSTRUCTION

The type of construction used is not of great importance electrically, since only D.C. is being handled in all parts of the circuit. As a result, the lay-out can be determined by other considerations, such as the convenient arrangement of controls on the front panel. The system illustrated is a good one, though it could probably be improved upon by the exercise of a little ingenuity. The main point about the arrangement is that plenty of room is available for a large dial, with reasonably open scale markings. Next, the operating switch is mounted in an easily accessible position, and at the same time is not placed so that the dial setting is likely to be accidentally disturbed when it is pressed. The same considerations apply to the placing of the range switch and the "focus" switch. The various photographs show the arrangement of the parts quite clearly, so that a great deal of description is hardly required.

IMPORTANCE OF C_1

The success of the whole instrument depends upon the choice of a good condenser, for the position of C_1. Any leakage will in the first place prevent the timer from having the desired range, and will cause the maximum time interval to be much less than it should be. Worse than this, if the condenser has appreciable leakage, the degree will undoubtedly vary from time to time, utterly destroying the accuracy of the instrument and thus defeating its purpose, which is to provide greater reproducibility than can be got by manual timing. It is for this reason that C_1 has been specified as an oil-filled condenser. These components have by far the best leakage characteristics of the many types of condenser available. We must emphasise that the usual tubular paper-dielectric condenser is by no means good enough for the job. It is not a question of breakdown, but of having a leakage resistance of hundreds of megohms rather than of only a few megohms. The latter is quite satisfactory for normal use as a by-pass condenser, for instance, but would be hopeless for timing purposes.

By the same token, all the wiring in the grid-cathode circuit of V_1 MUST have exceedingly low leakage. In this connection, it is worth while pointing out that rubber-covered wire should on no account be used in this part of the circuit. The best ordinarily available wire from this point of view is P.V.C. covered hook-up wire, which is really excellent.

CALIBRATION

It might be thought that this part of the job would present some difficulty, but such is not the case. It can be done quite well with the aid of a

watch with a second hand, preferably one of the long variety that extends right to the outside edge of the face. Of course, a stop-watch is best, if one can be obtained for the occasion. Best of all, but one which the average person is very unlikely to have available, is an electrically operated stop-clock, which would enable the probable error to be measured and a very precise calibration to be made. However, extreme accuracy is not needed, for it is well known that all ordinary photographic processes, even the timing of exposures, need seldom be controlled to closer limits than plus or minus 10 per cent. The timer is easily capable of this performance.

The best way of performing the calibration is, first of all, to draw for each range a graph of angular movement of the pointer, against seconds. To do this, it is necessary to fit a temporary dial reading 0 to 100, or, better, 0 to 270. The latter will save some arithmetic if its calibration is direct-reading in degrees. In either case, the dial will need to have divisions spread over 270 degrees, since the potentiometer will move over this range. For indicating purposes, a lamp should be connected into the enlarger socket, so that it will not be necessary to rely on the sound of the relay. Next, the range switch, S_1, is opened, to give the long range, and S_3 is opened. The watch is allowed to run, and R_2 is set to its maximum value, giving the longest time. Then S_2 is pressed and held down until the second hand of the watch is just passing a specified mark on the face, and the switch is released. When the light goes out, the time is noted, and the interval between the release of the switch and the going off of the light is worked out. The same measurement is carried out at least a dozen times, to compensate for inaccuracy in reading the watch, and the average of the several readings is taken. Now, the dial of the timer is shifted by ten degrees, and the time for this position is measured in the same way as before. The process is continued until the end of the potentiometer's travel is reached. It is now possible to draw, to a suitable scale, a graph of times against dial readings. If the temporary dial readings gave readings in degrees, no further work need be done for this range till it comes to drawing out the final direct-reading scale. If the dial units are arbitrary ones, it is necessary, before drawing the graph, to convert these to degrees. This is done simply by finding out how many degrees each dial division represents.

To draw the final scales, a protractor is used to lay out the divisions and the graph enables the number of degrees from the starting point to be read off for any desired round number of seconds. The same system exactly is used to calibrate the short range and to draw its scale. When the dual scale has been drawn, it can be set in place by means of stout glue and covered with a thin sheet of celluloid. The pointer is properly located on the shaft by turning the latter until the greatest measured time interval is indicated on the watch, by trial and error. When this setting has been found, the pointer reads the time used in the final check. When this has been done, all other intervals will read correctly.

TONE-CONTROL SYSTEMS

By C. R. LESLIE

Although the incorporation of a tone control is almost a universal feature of the receiving sets of to-day, the full significance of this addition may not be generally appreciated. The following discussion may be of interest to those desirous of constructing their own amplifiers or of improvement in the quality of their sets.

INTRODUCTORY

Probably every listener has noticed that as the volume control of his set is turned, the BALANCE of tone is varied as well, so that the same quality is not obtainable throughout the sweep of the control. This will also be experienced even if the amplifier has a very level response curve through a wide audio range. The reason for this is mainly due to the characteristics of the human ear, which are logarithmic rather than linear, and will vary from individual to individual. The practical effect is that when the volume is reduced the frequencies below about 200 c/sec. are attenuated considerably more than the middle and upper ranges, and, conversely, with a steady low intensity level of about 40 db., as the frequeney is increased from about 100 c/sec. (which is then just inaudible), the output level increases to beyond 1000 c/sec., and after 2000 c/sec. the output level shows a progressive decrease again. These effects are complicated by speaker and cabinet resonances and the acoustics of the room. As the theoretical ideal is to experience the full quality of the transmitted programme at any convenient volume level desired by the listener, it is obvious that some form of adjustable tone compensation is essential. With "electric gramophones" we have the additional defects inherent in the record; generally speaking, the very low frequencies are amplitude limited to avoid excessive needle swing, which might cause a break through the walls between adjacent grooves, and also, unless special precautions are taken, there will be a superimposed "needle scratch." In such cases the scratch frequencies need to be filtered out and "bass boost" introduced to compensate for the amplitude loss of the lower frequencies.

The question of tone control or compensation may be conveniently considered under the two main headings of "normal fidelity" and "high fidelity," and under two main-purpose sub-headings of "radio transmission reception" and "gramophone reproduction," since the requirements of the latter two groups are somewhat different.

As the middle audio range is the most linear portion of the ear's characteristic, compensation usually takes the form of adjusting a balance of the higher and/or lower frequencies about it, and the system is given the pleasing title of treble or bass "boost." It should be obvious, however, that if the amplifier is working at full volume there cannot be any treble or bass boosting. In practice, it is usual to simulate treble boost by bass attenuation, and vice versa. Actual boosting can only be achieved by the addition of an extra valve or by having ample output power in reserve. For instance, suppose the normal output is one watt, then, if the bass is increased by 10 db. (i.e., 3.2 times), the output stage will have to be capable of handling 10 watts at the low frequencies (remembering that power is proportional to the square of the voltage).

AN OUTLINE OF VARIOUS SYSTEMS

During the past ten years or so, a great many circuits have been tried, and it is not possible to describe them all, but as they mainly consist of variations of certain definite principles we may examine these. Broadly speaking, tone compensation can be effected by any of the following methods, which will be dealt with separately:—

(1) By the use of resonant filters.
(2) By the use of resistance-capacity filters.
(3) By the use of negative frequency feedback.
(4) By the use of automatic tone control in association with the A.V.C. system.

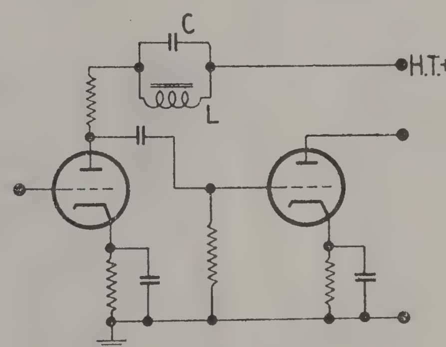


Fig. 1.

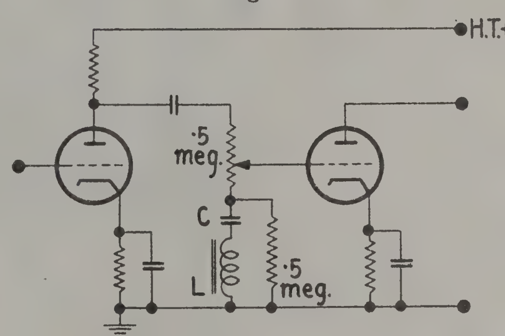


Fig. 2.

(1) Resonant Filters:

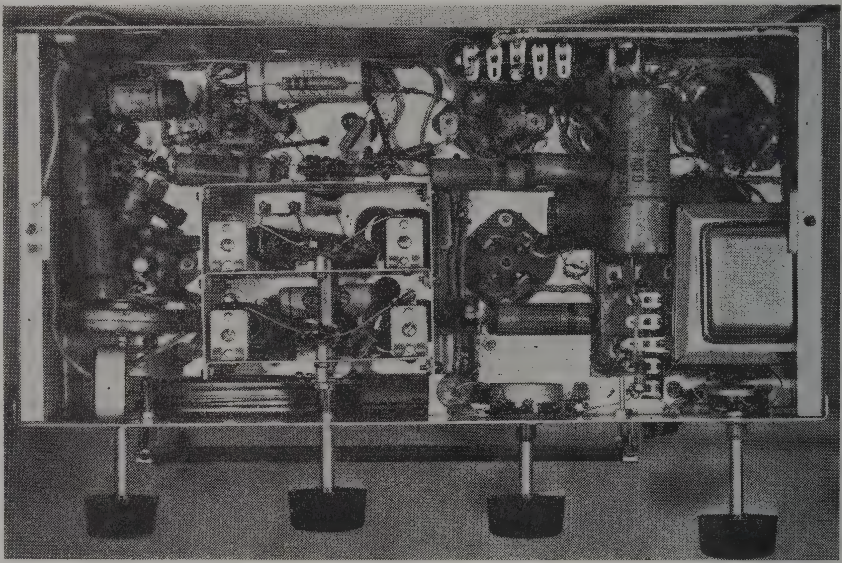
As the name implies, these consist of resonant circuits—rejector types for boosting and acceptor types for filtering out certain frequencies. They may be inserted in the anode or grid circuits, the rejector type being more common in the anode circuit, as shown in Fig. 1, which should be self-explanatory. The system is particularly adaptable for securing a better balance between volume control and tone

(Continued on page 46.)

A HIGH-QUALITY SIX-VALVE DUAL-WAVE RECEIVER

This receiver presents something out of the ordinary in the way of six-valve circuits, and has a high-quality audio system capable of eight watts output. It employs the British KT61 high-sensitivity output tetrode in the final stage, two tubes in parallel being used to give the power quoted, with a generous degree of inverse feedback which results in low harmonic distortion.

Our observations over a period have convinced us that the amateur constructor of radio receivers is not nearly as interested as he used to be in building "simplified" designs for small and medium-sized sets, and has become much more concerned with obtaining high performance. With this idea in mind, we have designed the present set to give really superior results as far as power output and audio quality are concerned. The R.F. end, however, has not been skimped, and consists of a line-up found in the majority of commercial five-valve sets on the market to-day. At the same time, there is no reason why a constructor should not incorporate such improvements to the R.F. part as he may see fit, such as adding an R.F. amplifier and substituting an infinite impedance mixer; the unusual part of the present design is rather in the detector and audio portion of the set, so that while a quite satisfactory R.F. section has been provided, no attempt has been made to feature any innovations.



GENERAL CONSIDERATIONS

It is a well-known fact that by far the most listening done on a particular set is to the local programmes, and that while few would voluntarily be without facilities for distant broadcast or shortwave reception, these things are really subordinate in importance to quality of reproduction when the receiver is tuned to a strong enough signal to ensure that such is possible. This statement is the basis on which this receiver has been designed. We will therefore describe the detector and audio system first.

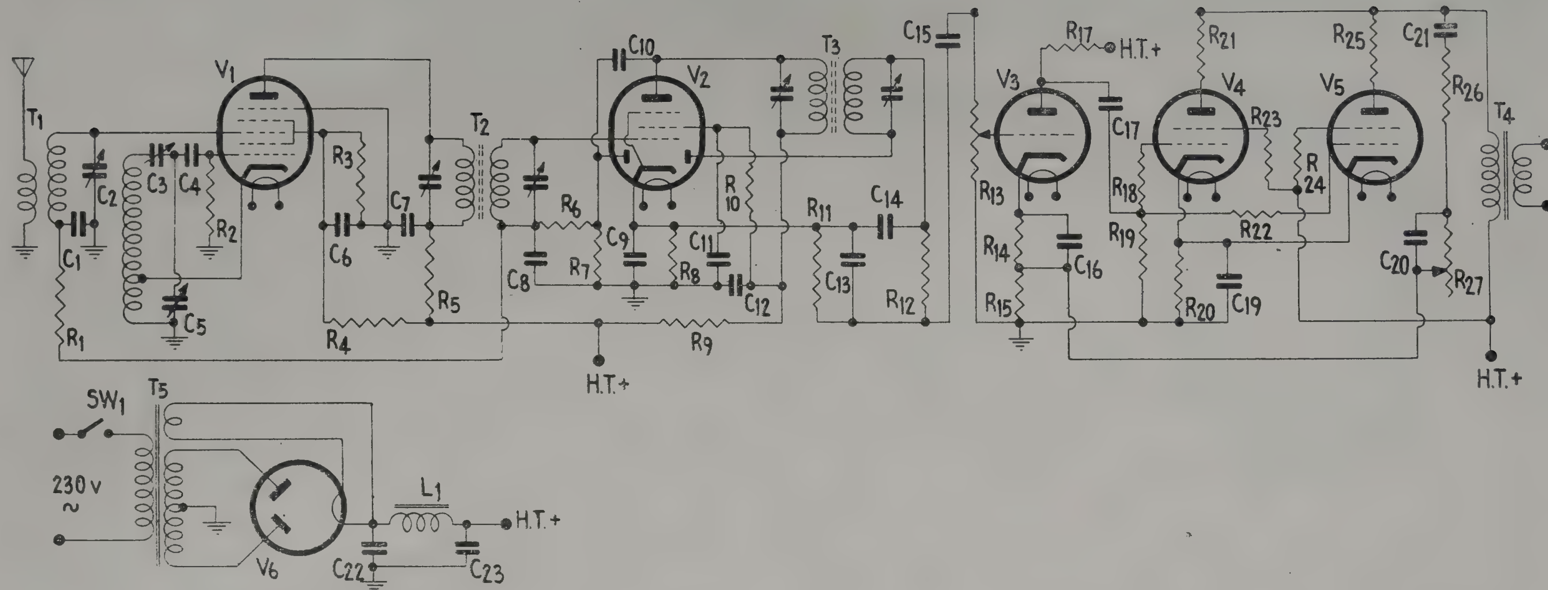
As stated above, the output stage consists of two beam-tetrodes in parallel. The tubes are of a type that is comparatively unknown, the Osram KT61. They have the unusually high mutual conductance, even for British tubes, of 10.5 ma./v., and require the almost ridiculously small input of 4.3v. peak in order to load them to full rated output of 4.3 watts each. Thus, two of them in parallel are capable of 8.6 watts output for the same input voltage. Now, because of their extraordinary sensitivity, it is possible to apply a very high degree of negative feedback, and still have an amplifier stage of power sensitivity comparable with that of the average beam tetrode or pentode working without any feedback at all. Incidentally, these tubes were originally designed to have enough sensitivity for the usual first audio stage to be dispensed with. However, if the advantages of negative feedback are to be realised to the full, a low-gain first audio stage is still desirable, and here we have used a 6J5 with feedback connected from the plate of the output stage to the 6J5 cathode.

The I.F., second detector and A.V.C. rectifier functions are all fulfilled by the 6B8, which is V_2 in the diagram.

The remainder of the circuit comprises a 6SA7 oscillator-mixer which was used in our prototype with a commercial dual-wave coil unit. The performance of the set both on broadcast and on the short-wave band is equal to anything we have heard in the way of sets which do not employ an R.F. stage.

THE CIRCUIT IN DETAIL

Commencing with the output stage, it will be seen that series resistors or stoppers have been placed in the connections to each electrode of the two tubes. Thus, instead of connecting together directly the grids, plates, and screens, these resistors are connected at the valve pins, and the electrodes are paralleled by connecting together the far ends of the resistors. This is a very necessary precaution when high mutual-conductance valves are paralleled, because of the strong possibility of parasitic oscillation if they are omitted. Only the grid-stoppers are of any size, however, being 100k. in value, but the plate and screen stoppers are only 25 ohms each. It is fortunate that this low value is satisfactory, because



COMPONENT LIST

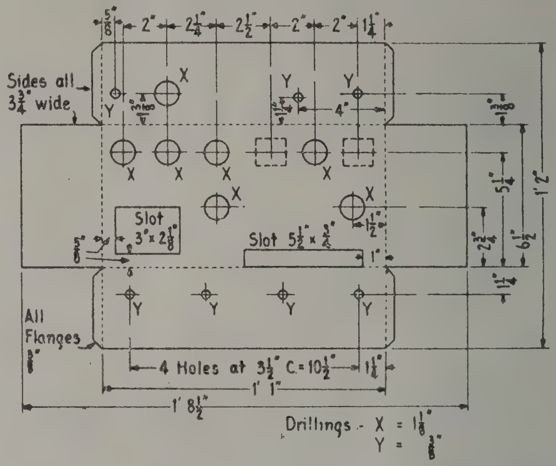
C_1, C_6, C_7, C_{11}, C_{12}, C_{15} = 0.05 mfd. paper.
C_2 + C_5 = gang condenser.
C_3 = padder, in coil unit.
C_4, C_{13}, C_{11} = 0.0001 mfd. mica.
C_8, C_{17} = 0.1 mfd. paper.
C_9, C_{16}, C_{19} = 50 mfd. 25v. electro.
C_{10} = 50 mmfd. mica.
C_{20} = 0.001 mfd. paper.
C_{21} = 0.5 mfd. paper.
C_{22}, C_{23} = 16 mfd. 450v. electro.
T_1 = aerial coil, in coil unit.
T_2, T_3 = I..F transformers, 465 kc/sec., iron-cored.
T_4 = output transformer, 3000 ohms to voice-coil.
T_5 = power transformer, 330–0–330v., 100 ma., 5v., 2 amp., 6.3v. 2 amp.
L_1 = 100 ma., 20 H. smoothing choke.
V_1 = 6SA7.
V_2 = 6B8-G or 6B8 metal.
V_3 = 6J5 metal or 6J5–G.
V_4, V_5 = KT61.
V_6 = 80.
R_1, R_{10} = 50k.
R_2 = 20k.
R_3, R_{12}, R_{18}, R_{22}, R_{17} = 100k.
R_4 = 15k.
R_5, R_9 = 2k.
R_6, R_7, R_{11} = 1 meg.
R_8 = 250 ohms.
R_{13} = 1 meg. pot. (volume).
R_{14} = 1.5k.
R_{15} = 1k.
R_{19} = 250k.
R_{20} = 50 ohms.
R_{21}, R_{23}, R_{24}, R_{25} = 25 ohms.
R_{26} = 200k.
R_{27} = 2 meg. pot. (tone).
Sw_1 = S.P.S.T. on/off.

too high a value in these positions would cause both loss of D.C. voltage, and loss of audio power in the case of the plate resistors. The manner in which the stoppers work is quite simply explained. If high-frequency voltages tend to develop, say, at the grids of the tubes, they are prevented from doing so by the action of the grid-stopper in conjunction with a circuit element that does not appear on the diagram, but which is, nevertheless, a real one, namely the grid-cathode capacity of the tube. The grid-stopper and this capacity form a simple low-pass filter, and should the wiring and the rest of the valve capacities form unintentional tuned circuits at some high frequency, in such a way that the valve could act as an oscillator, this filter prevents the oscillation from building up. It is usual to see stoppers in series with the elements of even single high Gm tubes, but when two or more valves are placed in parallel, the possibilities of parasitic oscillation are greatly increased, and the stopper resistors became an absolute necessity rather than simply a precaution.

Care should be taken in the mounting of the stopper resistors to see that they are connected as close to the valve pins as possible. In fact, the proper way to mount them is to use the appropriate pin as one support, cutting off the lead as short as will leave just enough wire on the resistor to solder to the pin. If they are not connected in this way, their effect as parasitic preventives is liable to be lost.

The negative feedback consists of C_{21}, R_{26}, R_{27}, and R_{15}. The first of these components is merely a large blocking condenser, whose job is to remove D.C. from the rest of the network. R_{27} is the tone-control, and its action will be described a little later. For the moment we will assume that it is set so that no resistance is in circuit, and therefore C_{20} is short-circuited. In this case, the feedback network reduces to a voltage divider comprising R_{26} and R_{15}. To the junction of these resistors is connected the cathode of V_3, the audio voltage amplifier stage. Thus, the function of the voltage divider is simply to ensure that the appropriate fraction of the output voltage is fed back. The values in this part of the circuit have been so chosen that the gain-reduction-factor has a value of 4. This means that the gain of the audio amplifier as a whole is reduced by feedback to one-quarter of its value before feedback was applied. As a result, the distortion is also reduced to a quarter of the value that would exist in the audio portion of the set had feedback not been used. In addition, this makes possible 12 db. maximum bass boost that can be obtained by manipulating R_{27}.

When R_{27} is at maximum, being a 2 meg. control, it can virtually be regarded as an open circuit. Thus, C_{20} is effectively placed in circuit. Now, since C_{20} has a value of only 0.001 mfd., and because R_{15} is only 1000 ohms, it follows that there must be considerable loss at low audio frequencies in the voltage fed back to the cathode of V_3. There is therefore less reduction of gain at low frequencies than there is at middle and high frequencies. This, in effect, is the same thing as saying that the amplifier has more gain at low frequencies than elsewhere, and the bass register has been boosted. When R_{27} is at intermediate values between the two extremes that have been used for illustrative purposes, there are smaller degrees of bass boost. The latter is quite independent of the high-frequency response of the receiver, which remains entirely unchanged while the tone control is in use. Thus, the usual behaviour of tone controls, i.e., to cut the response at the treble end of the scale, is not followed at all. This makes for much better quality reproduction at all times, and in particular when the user of the set prefers a generous amount of bass. This is available, but not at the expense of the treble response.

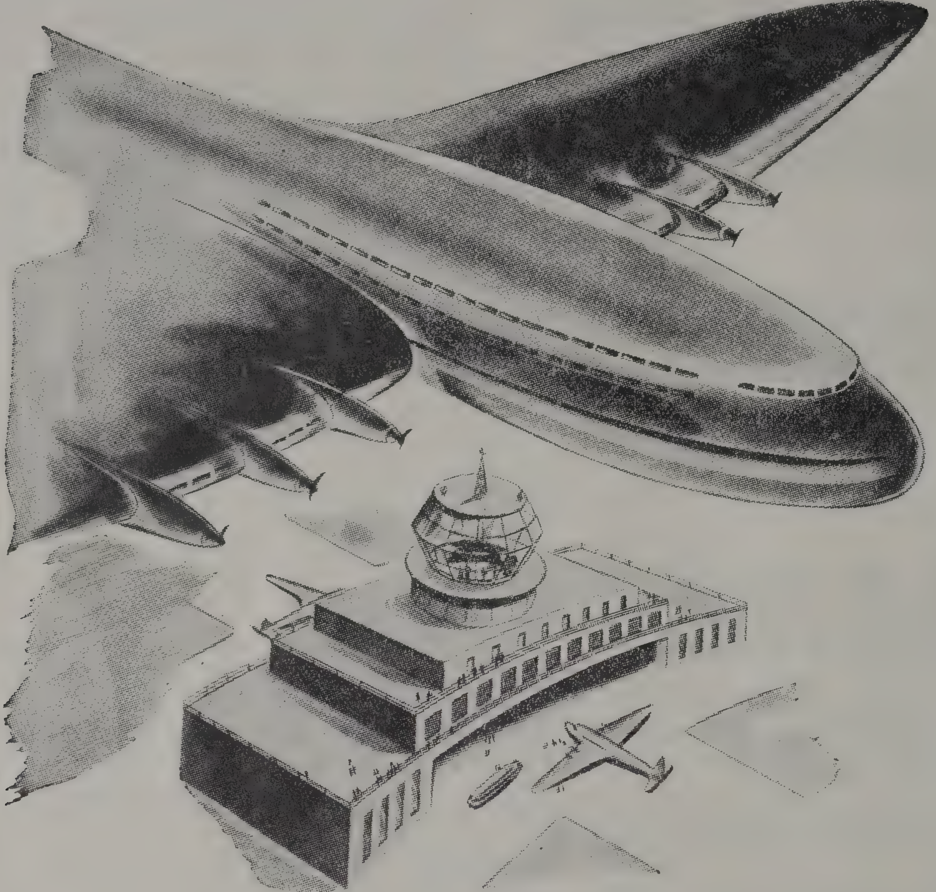


Working drawing of chassis for the receiver. The dotted squares show the positions of the I.F. transformers.

The circuit of the I.F., 2nd detector, and A.V.C. tube, V_2, is quite conventional, though having all this part of the circuit concentrated round the one valve makes it look a bit more complicated than it really is.

R_{11} is the detector diode load resistor, across which the volume control, R_{13}, is connected. The latter acts as the grid-leak for V_3. R_{12}, C_{13}, and C_{14} comprise the usual filter to help keep I.F. voltages out of the audio stages, where they may cause trouble.

The receiver built in our laboratory used a commercial dual-wave coil unit, designed for a 6SA7 oscillator-mixer. Our circuit diagram has been drawn as a single-band affair for the sake of simplicity, so that the aerial coil, T_1, and the oscillator coil and padder, C_3, are not separate components which have to be purchased. The unit itself is sold with a leaflet which shows how the wiring should be done. This is very simple, as only a small number of leads emerge from the unit. These are: (1) The aerial lead; (2) the mixer grid lead; (3) the oscillator cathode lead; (4) the lead from C_3 which goes to the oscillator grid condenser; and (5) the lead from the bottom of the mixer grid coil, which is connected to the A.V.C. line through the decoupling resistor, R_1. In addition to these, there are two leads of wire braid for earthing purposes. Of course, there is no reason why a coil unit should not be used that is designed for another type of oscillator-mixer tube. The unit illustrated is sold with a matching dial mechanism and dial plate, and also, if desired, with a cabinet specially arranged to take the manufacturer's own design of chassis. The chassis used in the original model was the one provided by the manufacturer of the coil unit for the building of



a five-valve set round the unit. All that was necessary was to make an extra valve-socket hole to take the first audio stage. The power supply is a standard condenser input affair, and uses a 100 ma. smoothing choke. This rating is theoretically a little on the light side, but only by a few milliamps, and that only when the set is running at full gain. The extra expense of a 120 ma. choke is therefore not justified, as the one specified will do the job perfectly well, without overheating or any risk of burn-out.

ALIGNMENT

The alignment of this set is no different from that of any normal superhet. employing a 465 kc/sec. I.F., and as the correct procedure has been outlined many times in these pages, we do not intend to repeat it here. The performance from the R.F. point of view is excellent, and comparable with that of any good receiver with a similar line-up before the second detector. The audio performance is superior to that of most receivers that do not employ a push-pull output stage, and is undoubtedly much better than that of any set, single or push-pull, that does not include negative feedback in the design. In fact, there are very good arguments that can be brought forward in support of the scheme used here, as against that of push-pull beam tetrodes, with which the problem of efficiently applying negative feedback is quite a difficult one if the cost is to be kept to reasonable proportions. We would strongly recommend the use of a good console cabinet and a high-quality loudspeaker, if the pocket will run to them, because the quality of which the set is capable is good enough to make such extra expenditure worth while. However, even if a mantel cabinet

(Continued on page 48.)

THE PREDICTION OF OPERATING CONDITIONS FOR THE AMATEUR TRANSMITTING BANDS

Elsewhere in this issue will be found what is a new departure for "Radio and Electronics," namely some tabulated data predicting the times during which various amateur bands can be expected to be open, for a number of transmission paths, for the month of March, 1948. The preparation of these predictions entails considerable work, but we are convinced of the usefulness of such tables, and that much valuable information is contained therein. This is not only a matter of personal opinion, but of the accumulated experience of a number of organisations vitally interested in radio communication over long distances. It was not until approximately the beginning of the late war that ionosphere predictions on a world basis began to be placed on so sound a footing that much reliance could be placed in them. However, so great was their importance to the armed services that the amount of observation of the characteristics of the ionosphere was rapidly expanded through the setting up of many new recording stations. This vast increase in the volume of data upon which predictions can be based had the desired effect of greatly enhancing the accuracy, and therefore the value, of the predictions issued by the two co-ordinating authorities, namely the Australian Radio Propagation Committee and the Central Propagation Laboratory in the U.S.A.

Experience over the war years in the working of long-distance radio circuits with the aid of the predictions has shown that in the main their reliability is excellent. The writer has carried out investigations similar to those made by many different organisations, into the correlation between the actual and predicted performance of set frequencies on given propagation paths, and has been much impressed with the way in which even such matters as relative signal strengths at different times when predictions stated that the circuit should be in operation were accurately forecast. One case that can be recalled is that of a circuit between New Zealand and Canada. The actual working of the various frequencies allotted to the circuit was estimated on a monthly basis so as to compare readily with the predictions, which are made from month to month. From memory, over a period of several months during which the comparisons were made, **in no case did the predictions forecast that a given frequency would be usable when in practice it was found not to be so.** Of course, this statement applies to the performance of the circuit averaged over the month, and must not be taken to mean that on no one day was any discrepancy found. This point will be enlarged upon later. The important thing to note here is that if the predictions had initially been taken as a guide, and the various available frequencies brought into use according to their recommendations, the circuit performance would have been at least as good as was obtained by a trial and error process, and in many cases much better. In short, no more complete vindication of the predictions could be found.

It should be pointed out that the day-to-day behaviour of the ionosphere cannot be foretold by these forecasts. Such disturbances as are caused by sun-spots and auroral displays can be predicted only a few days or even hours in advance, and in any case cannot be charged against the predictions as failures. Neither can the fact that abnormal conditions often occur which actually allow communication to take place on frequencies that are "out" according to forecast.

In short, the predictions should not be regarded as infallible, because they are not. When it is realised that they refer to average **normal** conditions of the ionosphere, and that exceptional conditions can occur, without in any way reflecting upon the general accuracy of the forecasts, one is in a position to derive great benefit from their use.

For example, if it is predicted that between certain hours no communication can be expected with W8 or G call signs on 20m., then a great deal of fruitless knob-twisting can be avoided, and the time spent to better advantage. Conversely, if it is desired to choose the best possible time for a long-distance schedule, it will be found almost impossible to do better than pick on a time in the **middle** of a period during which the predictions are favourable for the path and frequency in question.

None of the above should be taken to mean that actual experience of good conditions, say the day before, should be ignored when weighing up the possibility of a contact. Abnormal conditions sometimes turn up at the same time of day for a few days running, but a useful rule is that the further a particular condition of the band deviates from the predicted one, the less the likelihood of the same freak condition occurring at the same time the next day, or at all, for that matter.

University

OSCILLATOR KIT MODEL OK1

At last you can build your own oscillator with an assurance of success and accurate calibration. Model OK1 is a companion instrument to the very popular Model MK1 multimeter. In fact, it is fitted into a strong steel box of exactly the same dimensions, namely, 6" x 8" x 2½", with a leather carrying handle fitted to the top. The box is attractively finished in black brocade and is faced with a beautifully eached label finished in black and nickel.

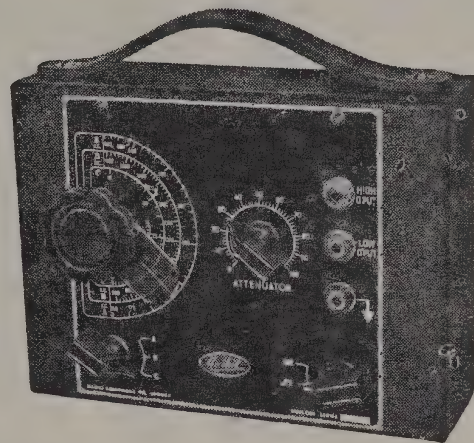
This is just the instrument for carrying around on your service calls as it permits accurate re-alignment of a receiver in the customer's home. Alternatively, it will take up a minimum of space on your work bench and will enable you to align broadcast or dual wave sets with extreme ease.

The OK1 operates from a set of batteries built inside the case. It provides a carrier wave, modulated at approximately 400 cycles at any point in the popular intermediate frequency, broadcast or short wave band. The actual frequency coverage is 160 to 490 kilocycles on the intermediate band, 550 to 1600 kilocycles on the broadcast band, and 16 to 45 metres on the short-wave band.

The principal feature of this instrument is that the heart of it, that is, the three tuning coils, the wave-change switch, valve socket and tuning condenser, are all wired together as a unit before the instrument is despatched to you. Not only is this difficult portion of the wiring carried out for you, but, further, this section of the instrument is connected up to batteries and is thoroughly tested and pre-calibrated in our test rooms before being despatched to you. Thus, you are not confronted with the laborious and difficult task of calibrating an instrument after you have constructed it. The frequency calibrations are heavily etched into the brass panel and are clearly marked to facilitate rapidly setting the instrument to whatever frequency is required. Each of the coils used has its own individual adjustable iron core and these adjustable cores, in conjunction with a trimmer condenser, enable us to accurately pre-test and calibrate the instrument for you before it leaves our factory. Because of this, you can be certain that your oscillator will not only work after you have completed its construction, but also that the calibration will be accurate within ± 2%. All you have to do to complete the construction of your instrument is to mount the few remaining parts that are not already assembled in place, complete the non-critical wiring, connect up the batteries and your instrument is ready for use.

Full instructions for completing the construction of the instrument and for its use are contained in a booklet which is included with the kit of parts.

The diminutive size of this compact instrument is made possible by the use of the latest types of miniature valve, coils and battery. The valve used is one of the miniature bantam series. This valve type has been chosen not only on account of its small physical size but also on account of its extreme economy in battery current. The filament current is



only 50 milliamps and consequently the "A" battery comprises two standard type torch cells which are readily available in any district. On account of the low current drain and the intermittent use given an oscillator, these cells should provide approximately six months of operation.

The "B" battery is one of the latest 45-volt plug-in batteries. This battery will probably have a life of about 12 months under normal operating conditions.

A specially tapered carbon type attenuator is used to vary the strength of the output signal and to assure a smooth control, a voltage divider and two separate output sockets are provided. The voltage divider has a ratio of 100 to 1 so that signals from the output socket marked "Low Output" are one-hundredth of the strength of those from the "High Output" socket.

The Model OK1 is confidently recommended to you as an economical and efficient instrument, highly suitable for the alignment of radio receivers and for the location of faults in sets by means of an analysis of the receiver's performance stage by stage. The kit includes the batteries, operating instruction booklet, shielded output cable, and in fact is complete to the last nut and bolt.

IT'S A University INSTRUMENT

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32-161, 32-162.	43-590, 46-651.	36-736.	11-531.

The Classification of Radio Position-finding Systems

That considerable progress was made during the war in the associated fields of radiolocation and radio-communication is common knowledge, since it has been exhaustively described in the papers, which were presented to the two conventions held under the auspices of the Institution of Electrical Engineers in 1946 and in the spring of 1947. Engineers generally have been able, therefore, to acquaint themselves with the developments which have taken place, while radio specialists have been provided with a mass of information which should serve as a basis for fresh advances. As is also well known, much of this work was carried out under conditions of both stress and secrecy. Inevitably, therefore, overlapping and loose ends occurred; and these defects are exhibited in the literature, and especially in the nomenclature, of the subject. To obtain full value from what has been done it follows that a good deal of editorial work is desirable, and that codification is also required if there is not to be confusion. It must, in fact, be quite clear that when different writers use the same terms they mean the same thing. This pitfall is not invariably avoided at present, while the coining of code names to confuse the enemy is now tending to general mystification.

Mr. C. E. Strong did well, therefore, to devote the address which, as chairman, he delivered to the Radio Section of the Institution of Electrical Engineers, on Wednesday, October 15, to a consideration of the best way of classifying radio systems as a whole. He began by postulating that "radio" is divisible into two branches, dealing with communication and location, respectively. By so doing, he gave radiolocation a different and wider application than has hitherto been usual, but this may be excused on the ground that it would be difficult to discover an equally succinct and comprehensive term for that purpose. He further noted that existing classification of radiolocation is inadequate or ill-defined. For instance, while "direction-finding" is used to define those parts of the field concerned with reception, there is no equivalent term for denoting the transmission of azimuth information; and while the term radar is all too freely used, its application should, strictly speaking, be confined to systems in which the objects detected do not actively co-operate. In fact, there is a lack of the wider terms of definition, with the result that the general has often to be described in the terms of the particular. To bring order out of partial chaos, radiolocation systems could be classified by their methods of application. This is already done in the radio-communication field, where the terms telegraphy, telephony, broadcasting and television are used as simple functional descriptions. Another way would be to distinguish them by the technical means employed in their operation, such as modulation or channel separation. A classification of this kind, however, is not sufficiently detailed for radiolocation purposes, since, as Mr. Strong points out, such systems as Gee and Decca, although closely related in function, employ pulses and continuous waves, respectively, and must, for that reason, be included in different categories.

It is therefore desirable to start with first principles and to observe that the position of an object on a particular hyperbola can be determined by measuring the difference of its distances from two fixed points; and that, similarly, its position on a particular ellipse can be determined by measuring the sum of the distances from those points. In fact, as Mr. Strong shows, all radiolocation systems are either hyperbolic or elliptic position line systems, the one being concerned with direction and the other with range. As, in practice, these distances are measured in terms of the time of wave propagation, it follows that all systems of radiolocation may be placed in one of two main categories, depending on whether they can be described as being "direction-determination" or "range-determination" systems. Direction-determination systems can, in turn, be divided into those used for "direction-giving" or "direction-finding," respectively, although the main methods in use can be employed for both purposes. The former, for instance, would include Gee, Decca, omni-range beacons, overlapping beam course beacons, and all systems transmitting azimuth information; while the latter would embrace the receiving counterparts of these methods. The next sub-division could be between broad-based and narrow-based systems, since there are considerable differences in the application of the two. Range determination and direction-finding systems also would have to be sub-divided into radar and non-radar groups. Further, those which do and do not require co-operation could be differentiated.

The segregation of the various systems on these broad lines is not, however, enough. Indeed, further separation according to the technical methods employed, in Mr. Strong's view, is essential. For instance, although both Gee and Decca are broad-based direction-giving systems and therefore fall into the same functional category, they employ widely differing technical methods. Carrying classification a step farther, it is therefore necessary to distinguish the various systems either according to the methods employed to mark the transmissions or according to the methods of modulation or channel separation employed. In the first case, the transmission is marked either by a succession of pips, as in Gee, while in the second, peaks and valleys of low-frequency sine-wave variation are impressed on the radio-frequency wave, as in the Benito ranging system. In the third, differences of distance are found in terms of the number of whole wavelengths and the fraction of wavelength by which one path is longer than another, as in direction-finding and omni-range beacons and in Decca. The main difference between these methods is that the first utilises pulses and, being discontinuous, is therefore inherently suitable for time-sharing methods of multiplex systems, and for time-discrimination between signals, while in the other two the transmission is continuous and the signals must be separated by using different frequencies.

If, however, modulation is used for classification purposes, a distinction must be made between systems which employ variable-amplitude and constant-amplitude methods. The latter, being akin to frequency modulation, is the fundamental form, as it is directly associated with variations in the time interval. In radiolocation, as distinct from radio-communication,

modulation can only be effected by spacing the antennæ and may, therefore, be described as "space-modulation." Channel separation, however, can be effected by using frequency multiplex systems, in which the channels are separated by frequency; or by "time-sharing multiplex," in which they are separated by time. In Decca, for instance, the channels are kept distinct by separating their frequencies, while, in Gee, the transmissions from the spaced points are on the same frequency but, being in the form of interlaced pulse trains, are kept distinct by time-sharing. In fact, the signals pass through the same receiver, but do not interfere with each other owing to the separation in time. The same distinction may be made between pulse-phase and tone-phase comparison-ranging systems. In the first, simultaneous transmission and reception are possible on the same site, owing to the fact that the outgoing and incoming trains of pulses are interlaced in time; while, in the latter, the incoming and outgoing signals are on different frequencies.

The system of classification as outlined by Mr. Strong, therefore, differentiates in the first place between radio-communication and radiolocation, the latter term being expanded to include all methods of position determination, including direction-finding and radar. Radiolocation can then be divided into two categories, respectively, covering "range-determination" and "direction-determination," while these, in turn, can be sub-divided into broad-based and narrow-based systems. In "direction-determination," too, a distinction can be drawn between direction-finding and direction-giving systems. A further differentiation can be made on the basis of the

(Continued on page 48.)

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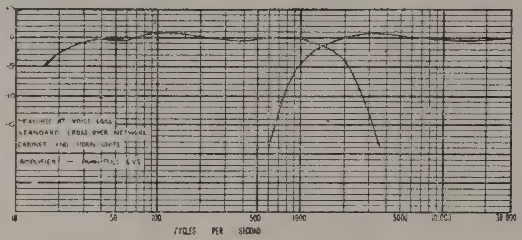
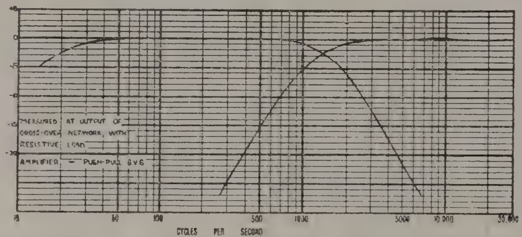
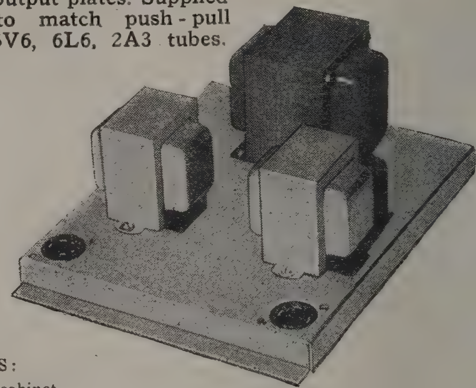


Measured at Voice Coils Standard Crossover Network Cabinet and Horn Units. Amplifier—Push-pull 6V6.



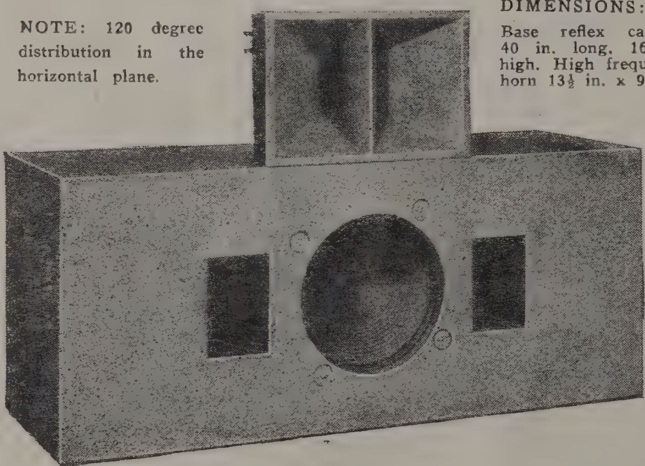
Measured at output of Crossover Network with resistive load Amplifier—Push-pull 6V6.

(1) A twin speaker system using cone speakers.
(2) A base reflex cabinet reduced to workable dimensions.
(3) A Crossover network of entirely new design which needs no other output transformer—couple it directly to output plates. Supplied to match push-pull 6V6, 6L6, 2A3 tubes.



NOTE: 120 degree distribution in the horizontal plane.

DIMENSIONS:
Base reflex cabinet 40 in. long, 16 in. high. High frequency horn 13½ in. x 9 in.



CROSS MODULATION AVOIDED

Avoidance of cross modulation has received special attention. This type of distortion is without doubt the most distressing of all and can only be avoided by use of a "split output" system.

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It is relatively simple to maintain a high degree of "presence" regardless of local acoustic conditions. Its realistic musical reproduction of both recorded and radio programmes at low levels and clear-cut consonental speech sounds at all levels, gives the listener a very real sense of being physically present at the original programme.

Inquiries invited for purchase of this new speaker system as follows:—
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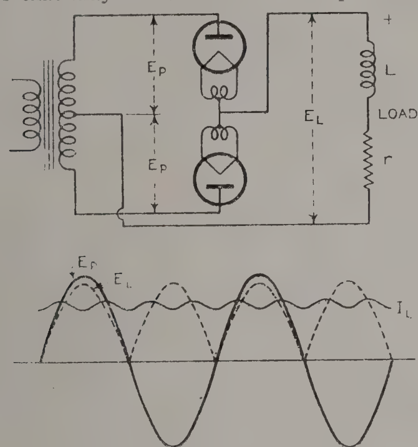
RADIO RECEIVER POWER SUPPLIES

By the Engineering Department, the Aerovox Corporation

PART I

The study of receiver power supplies is made up of two parts—the rectifier and the filter. These two parts, however, cannot be studied separately as they are interdependent. The action of the rectifier depends on the load into which it works, while the filter required for any particular application depends on the rectifier used and the character of output required. There are four different types of rectifier circuits that may be used for receiver power supplies:



$$E_{DC} = \frac{\sqrt{2}\, E_P\, P \sin \frac{\pi}{P}}{\pi} \text{ VOLTS} = \frac{2\sqrt{2}\, E_P}{\pi} \sin 90^\circ$$

$= 0.909\ E_P$ FOR FULL WAVE

E_P = RMS VOLTS TO NEUTRAL
P = NUMBER OF ANODES
(1 FOR HALF-WAVE RECTIFIER; 2 " FULL " ")

HARMONICS

$$A_n = \frac{2 E_{DC}}{n^2 - 1} = 0.667\ E_{DC} \text{ PEAK} = 0.471\ E_{DC} \text{ RMS}$$

AT MIN. FREQ OF 2 TIMES FREQ. OF APPLIED VOLTAGE

FIG 1

the half wave rectifier, the full wave rectifier, the bridge type rectifier, and the voltage doubling type rectifier. Each type has a definite field of application. The voltage characteristics of the various types are tabulated in Table I.

In the analyses of receiver power supplies, the following features must be taken into account:

1. The output voltage required.
2. The allowable ripple voltage.
3. The static and dynamic regulation of the supply.
4. The peak voltages across the condensers of the system.

These various features depend on the type of circuit used and the constants of the circuit.

RECTIFICATION

Rectification as obtained by the use of the thermionic vacuum tube is a process in which the tube conducts current during half of the cycle when the plate is positive with respect to the filament. In certain tubes the tube does not begin to conduct until a threshold voltage has been reached. The tube current is limited by the space charge and filament temperature saturation. The current is also determined by the characteristic of the load into which the tube works. If the tube works into an inductive load the inductance tends to maintain the current flow after the tube has stopped conducting. Similarly, when the tube works into a capacitive load, the charge on the condenser tends to maintain a current flow after the conduction period. In the inductive circuit the maximum D.C. voltage is limited by the choke coil and is approximately equal to the average value of the voltage wave applied. With the condenser input the maximum D.C. voltage, at no load, is equal to the peak value of the A.C. voltage applied. With the choke input, the voltage applied to the filter is equal to the A.C. plate voltage less the tube drop. The voltage regulation of the choke input rectifier depends on the tube drop and the I.R. drop in the choke coil. With the condenser input type rectifier the voltage applied to the filter input is equal to the A.C. plate voltage less the tube drop. Regulation with this type of rectifier depends not only on the tube drop but also the drop in the average condenser voltage due to the discharge of that condenser. Therefore, the condenser input rectifier will have a larger percentage of voltage regulation than the choke type of rectifier.

FULL WAVE RECTIFIER

The full wave rectifier is most commonly used for receiver power supplies and will be discussed in two separate parts:

1. Choke input filter rectifiers.
2. Condenser input filter rectifiers.

As explained above, the D.C. output voltage of the choke input filter rectifier into the filter is equal to the average value of the A.C. plate voltage less the tube drop. For a sine-wave applied voltage and a choke of infinite inductance the average D.C. voltage is equal to 90.9 per cent. of the R.M.S. applied voltage per plate. The circuit and the wave shape of the full wave rectifier are given in Fig. 1. The harmonic voltages existing in a full wave rectifier are of double frequency of the applied A.C. voltage and the R.M.S. value of the ripple voltage applied to the filter input is 47.1 per cent. of the D.C. voltages.

The current in a choke input rectifier, with infinite inductance, is constant in magnitude and the current pulses in each tube are of rectangular shape. The current in each half of the transformer secondary flows only every other half cycle and therefore the volt ampere capacity of the secondary is 1.57 times the product of the D.C. volt amperes. The current in the primary is an alternating current of rectangular wave shape and its volt ampere capacity is 1.11 times the D.C. volt ampere output of the rectifier. In practical rectifier circuits, chokes of infinite inductance are not available, but chokes having inductances from 15 to 30 henries at their rated current, are sufficiently large to approach the ideal condition. Decreasing the size of the input choke, decreases the A.C. voltage drop in the choke and applies a higher voltage to the first filter condenser of the system,

thereby storing additional energy in the filter and increasing the D.C. output voltage. Use is made of this effect in systems having a variable load such as Class A.B. or Class B. amplifiers to reduce the voltage regulation of the system. The decrease in inductance is obtained by operating the choke on the knee of the magnetisation curve so that the inductance of the choke decreases with an increase in current. Inductances of this type are called swinging chokes.

The regulation of the choke input rectifier depends only on the tube drop, which is given in Fig. 4, and the I.R. drop in the choke, provided the choke inductance remains constant. This regulation may be made quite small by the use of mercury vapour tubes and chokes of small D.C. resistance.

CONDENSER INPUT FILTER RECTIFIERS

The use of a condenser across the filter input increases the available D.C. output voltage as the condenser acts as a reservoir of energy during the conduction period and discharges into the load when the tube is not conducting. The circuit and the output voltage waves are shown in Fig. 2. The output voltage wave is made up of two parts: part one, a portion of the sine-wave,. during the charging period; and part two, the discharge curve which is an exponential function. The mathematical analyses of this type of wave is quite complicated and it is simpler and quicker to use empirical methods for the determination of circuit conditions for this type of circuit. Manufacturers of rectifier tubes include as part of their tube specifications a series of curves, showing the D.C. voltage at the filter input terminals for each type of rectifier tube and for various types of filter loads. In addition, these curves may be replotted, as shown in Fig. 3, as a function of current and input capacity. The curves of Fig. 3 are plotted for a D.C. voltage output of 100 volts with current as abcissa and the peak A.C. voltage as ordinates. Since the charging time of the first condenser is limited to a very short part of the cycle, the time depending on the size of the condenser and the resistance across the condenser, the current during that period may reach high peak values. As the voltage drop in the tube is not constant but varies with the tube current, the available output voltage can only be obtained experimentally. The curves of Fig. 3 are plotted for zero tube drop and must be corrected for the tube used and the tube current to obtain the A.C. voltage required to deliver 100 volts D.C. The correction is made by finding the D.C. voltage drop, in the tube used, from the curves of Fig. 4 multiplying by 1.5708, the ratio of the peak value to the average value of a half sine-wave, and adding this voltage drop to the ordinate of curve 3. This value, when divided by 1.41, gives the R.M.S. plate voltage to deliver 100 volts D.C. into the filter. To obtain any other D.C. voltage, the A.C. voltage must be multiplied by the ratio of the desired D.C. voltage to 100 volts.

The harmonic voltages in the full wave condenser input rectifier are of double the frequency of the A.C. applied voltage, the magnitude depending on the size of the input condenser and the load across it. These values are given in Fig. 5. As in Fig. 3, the effect of the tube drop is omitted. The tube drop tends to decrease the ripple voltage so that the curves of Fig. 5 give the worst conditions.

The voltage across the first condenser is equal to the peak A.C. plate voltage less the tube drop. When

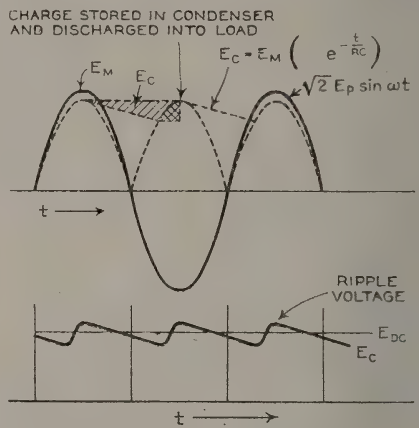


FIG. 2

there is no load on the power supply as is the case with the tubes of a receiver out of the socket or during the warming up period of the set, the peak voltage across the condenser is substantially equal to the peak A.C. voltage applied to the tube. As the load on the set increases, the peak voltage on the first condenser decreases by the amount of the tube drop. The peak value of the tube drop may be as

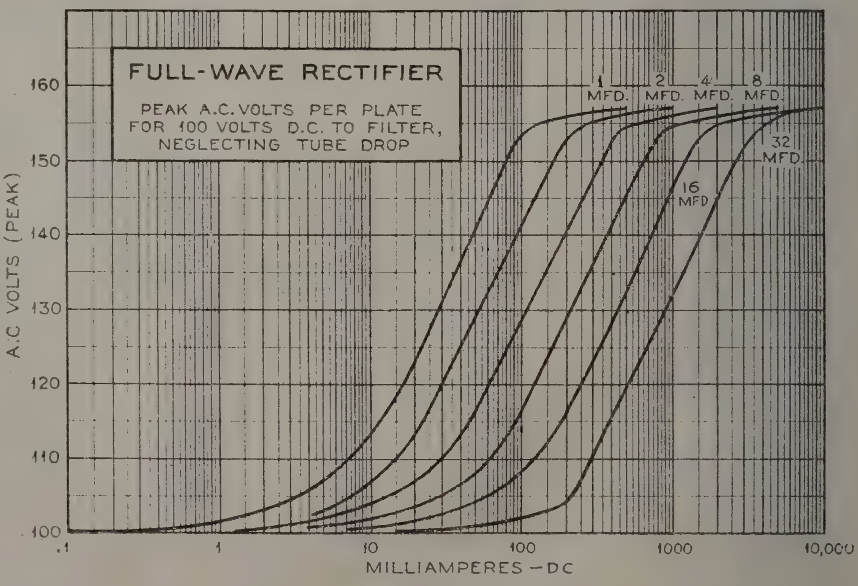


FIG 3

TABLE I

	WAVE FIG. 6 HALF	FULL WAVE FIG. 1	BRIDGE CIRCUIT FIG. 12	DOUBLING VOLTAGE FIG. 11
E_{dc}(av)	$0.458E_{ac}$	0.458_{ac}	$0.909E_{ac}$	———
I_{dc}	$0.318I_m$	1.41_{ac}	I_{ac}	———
E_{dc}(max.)	$1.41E_{ac}$	$0.707E_{ac}$	$1.41E_{ac}$	$2.83E_{ac}$
E_{ac} per plate	E_{ac}*	$0.5E_{ac}$	$0.5E_{ac}$	E_{ac}
E inverse max.	$2.83E_{ac}$	$1.41E_{ac}$	$1.41E_{ac}$	$2.83E_{ac}$
I_{av} per tube	I_{dc}	$0.707I_{dc}$	$0.707I_{dc}$	I_{dc}
I max. per tube	I_{dc}	I_{dc}	I_{dc}	———
Sec. kva.	$1.57E_{dc}\ I_{dc}$	$1.57E_{dc}\ I_{dc}$	$1.11E_{dc}\ I_{dc}$	———
Pri. kva.	$1.57E_{dc}\ I_{dc}$	$1.1E_{dc}\ I_{dc}$	$1.11E_{dc}\ I_{dc}$	———
Ripple freq.	f.	2f.	2f.	2f.
Ripple voltage rms.	———	$0.847E_{dc}$	$0.471E_{dc}$	———

E_{ac} = Transformer Secondary Voltage.

AVERAGE PLATE CHARACTERISTICS OF RECTIFIERS

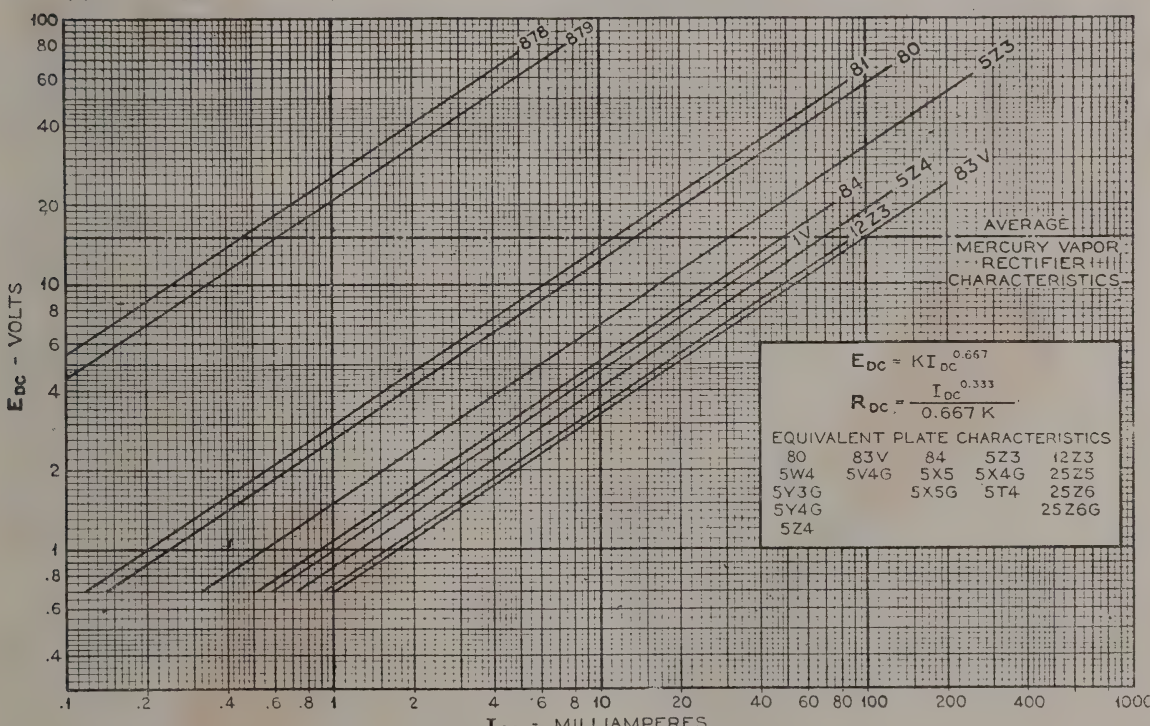


FIG. 4

high as 100 volts for tubes having a large voltage drop and used in filter circuits with a large input condenser. The tube currents depend on the ratio of the discharge time to the charging time and for circuits having a large load, that is, a low resistance across the first condenser and a large input condenser, the peak value of the tube current may be many times the R.M.S. value or the average D.C. value. The regulation of this type of rectifier, as explained above, cannot be computed but can be obtained from the graphs given.

To reduce the duty on the filter condensers of the system, use may be made of the fact that wet electrolytic condensers have a leakage characteristic

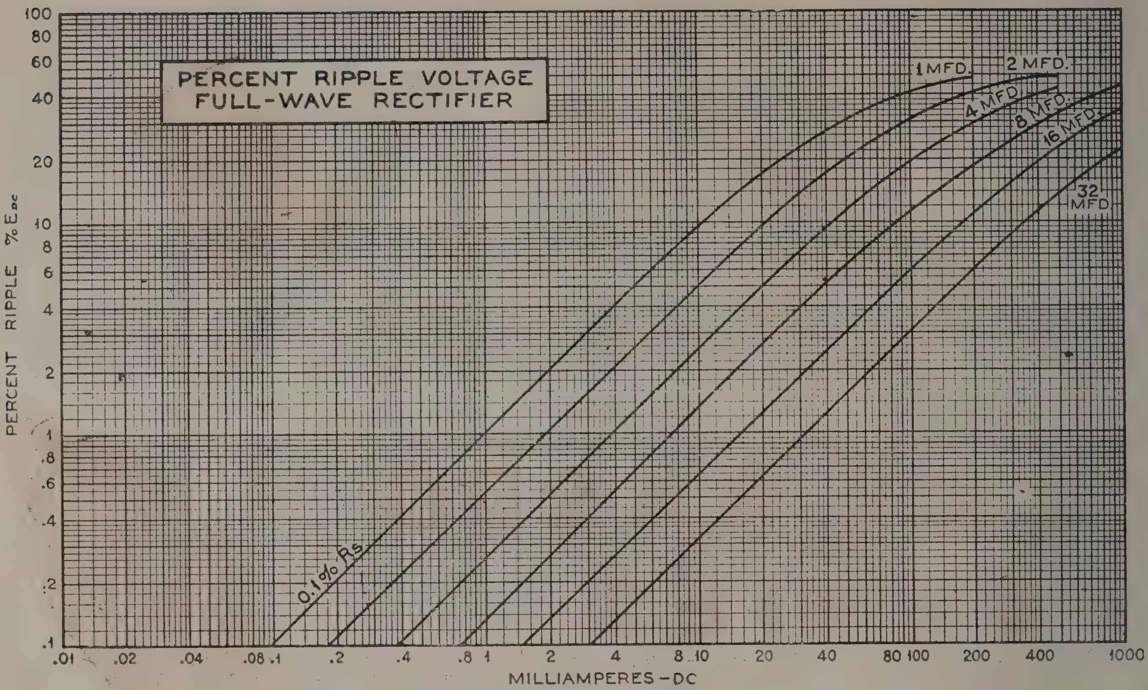
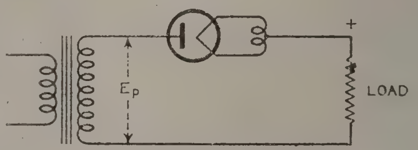


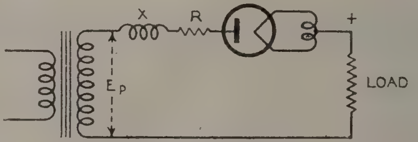
FIG. 5

which increases very rapidly with the applied voltage. Condensers of this type are called regulating condensers and by their use, the peak voltages that occur during the warming up period of the set or at no load, may be kept down to within the rated voltages of the condensers.

The half-wave rectifier utilizes half of the cycle of the A.C. applied voltage, the tube conducting current during half of the cycle. Because of this fact, the choke input type of filter is rarely used with the half-wave rectifier. In order to maintain the output voltage at reasonable values, a large input condenser must be used. The ratio of discharge time to the charging time of the half-wave rectifier is very large, about twice as great as for the full-wave condenser, and the discharge curve, being of exponential form, departs markedly from the approximately straight line curve that exists in the full-wave rectifier. Because of this fact, the determination of the D.C. output voltage of the half-wave rectifier can be obtained only from empirical data, the maximum D.C. output voltage at no load being 1.41 times the R.M.S. applied voltage. Fig. 7 gives the current and voltage curves in the half-wave rectifier and the curves of Fig. 8 give the peak A.C. input voltage, neglecting tube drop, required to deliver 100 volts D.C. into various types of filter circuits. The ripple voltage of the half-wave rectifier has a frequency equal to the frequency of the applied A.C. voltage, and this maximum value is determined by the capacity of the input condenser and the load across it. Fig. 9 gives the per cent. R.M.S. ripple voltage based on the D.C. output voltage. These curves are drawn for 0.1 per cent. series resistance in the tube.



HALF-WAVE RECTIFIER



EQUIVALENT CIRCUIT

$X = X_s + X'_p$
X'_p = PRI. REACTANCE REFERRED TO SEC
R = EQUIVALENT RECTIFIER RESISTANCE

FIG. 6

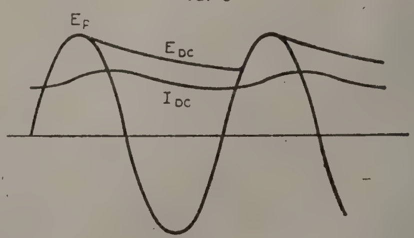


FIG 7

VOLTAGE DOUBLING RECTIFIER

An adaptation of the half-wave rectifier is the voltage doubling rectifier, in which the A.C. voltage

charges a condenser on alternate half-cycles so that the condenser discharges in series with the rectifier tube. By this means the maximum D.C. output voltage at no load is equal to twice the peak A.C. voltage applied. Since part of the output voltage is obtained by the discharge of a condenser, the greater the size of the condenser, the smaller will be the voltage drop of the system and the higher will be the D.C. output voltage, approaching two times the peak A.C. voltage for infinte capacities or zero load. The curves of Fig. 10 give the peak A.C. voltage required to deliver 100 volts D.C. to the filter, the tube drop being neglected, as in the previous curves.

The ripple voltage of the voltage doubling circuit is twice the frequency of the A.C. applied voltage, and the

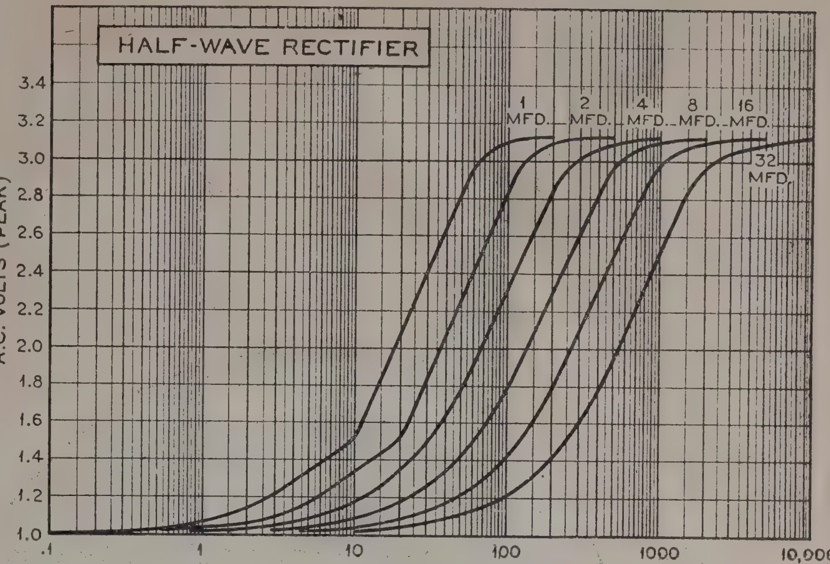


FIG. 8

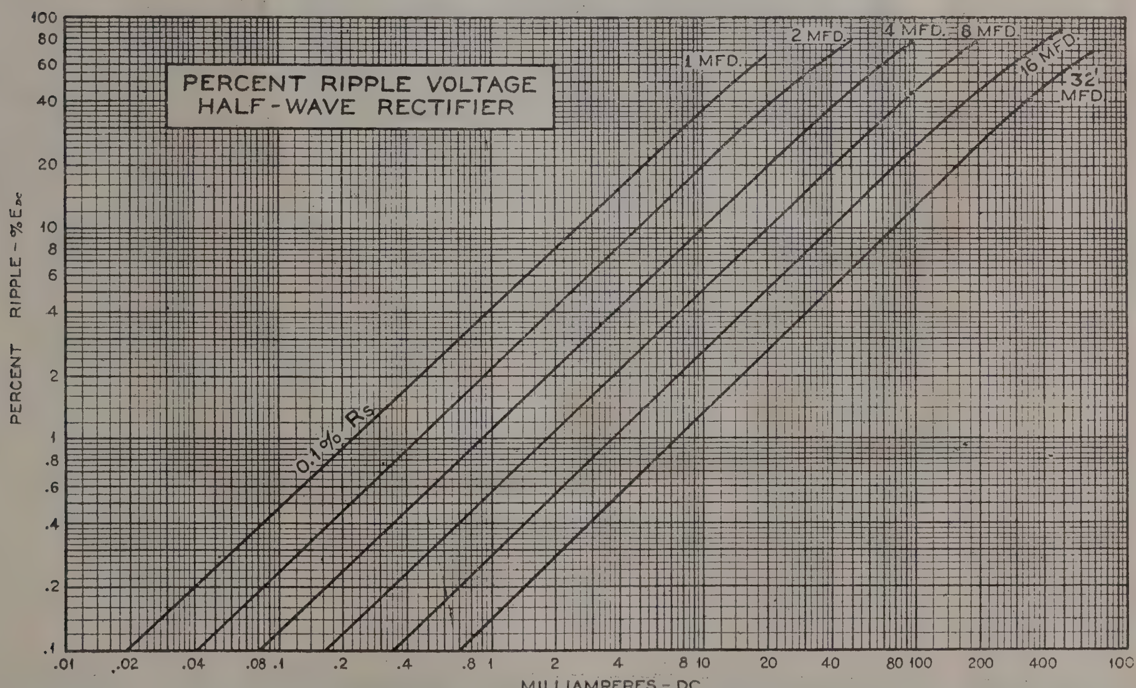
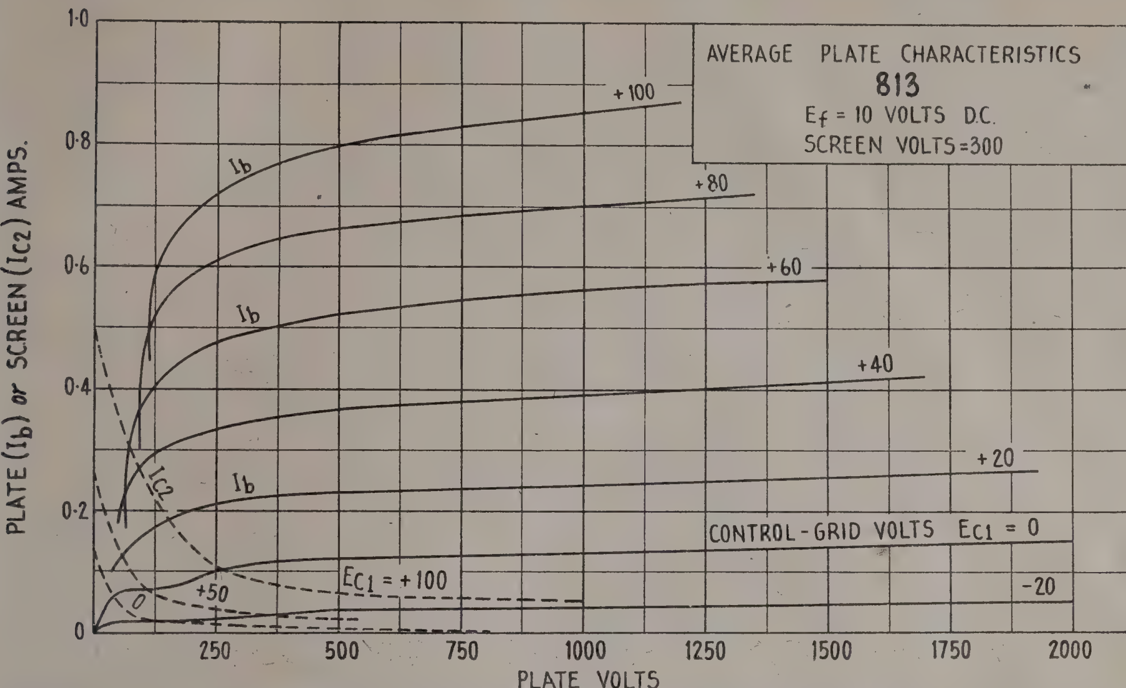


FIG. 9

magnitude is determined by the input capacity of the filter and the load across it. The curves of Fig. 9 give the ripple voltage for the voltage doubling circuit. The regulation of the voltage doubling circuit is not as good as the regulation of the full-wave rectifier, as the voltage output of the system depends on the capacity of the input condensers used.

(To be continued.)

TUBE DATA: CHARACTERISTICS OF THE 813 (concluded)



A Practical Beginners' Course

PART 18

The last instalment of this course described the construction and wiring-up of our first regenerative receiver. However, this type of set, which was once the only kind of receiver to use a single valve, needs quite some care and a little knowledge if the best results are to be got from it. The reason for this is that the regeneration or **reaction** control, as it is sometimes called, does not act in the same simple way as the volume control in an ordinary set. At the same time as increasing the volume, it also increases the selectivity, so that, unless the set has been very accurately tuned with C_1, the tuning needs to be checked after the volume has been increased by turning C_4. Also, unless the reaction control is very near the point where the valve goes into oscillation, weak, distant stations cannot be heard at all. Thus, a little tuition is very necessary.

MAKING THE SET OSCILLATE

If the wiring has been carried out according to instructions, the detector valve will oscillate quite readily when C_3 is turned past a certain point. The first thing to learn in operating the set is to know when oscillation is taking place. To do this, the aerial is disconnected, the phones are connected, and the set is turned on. The tuning condenser is set to about half-scale (that is, with the moving plates about half-way in) and the reduction condenser C_3 is turned VERY SLOWLY from minimum towards maximum capacity. While it is being turned, a sharp listen is kept in the phones, and after a while a faint hissing sound is heard. When this soft noise starts, it indicates that oscillation is taking place. Since the aerial has been taken off, the set should sound quite dead until the slight "rushing" noise indicating oscillation is heard. When you have heard this noise for the first time, and can recognize it when you hear it, the best thing to do is to practise setting the reaction condenser, since the better this can be done, the more easily will you be able to tune in those weak and hard-to-tune distant stations. Not that there is any great difficulty about tuning them in on this set, which works on the broadcast band, but great care and a steady hand on the controls are needed when it comes to making use of the same circuit to receive shortwave stations. You will notice that if C_3 is worked quickly, the set goes into oscillation with a loud "plop," but that if it is moved slowly, as we said above, the rushing sound starts gradually. Now for receiving stations that are sending speech or music, the correct setting of C_3 is at a spot JUST BEFORE the place where oscillation starts. This spot is where the set is in its most sensitive condition. If you manipulate the reaction control very carefully, you will probably be able to find a spot where the set is just not oscillating, but where faint noises like "static" on a big set can be heard. After about five minutes' practice at setting the reaction control, you will find that it is really quite easy. The next thing to do before attaching the aerial and searching for stations is to alter the setting of C_1, and then to reset C_3 to the point where oscillation has almost, but not quite, commenced. If you have moved C_1 by an appreciable amount, it will be noticed that the setting of C_3 to give the desired result is also different from the first one. In other words, at different settings of the tuning condenser, C_3 has to be re-adjusted to put the set back into its most sensitive operating condition. This is the reason why, although the regenerative receiver using a very few valves can be made as sensitive as a superheterodyne, the regenerative has fallen quite out of favour with the manufacturers, and with the public, too. This kind of set gets more results for the least amount of money and equipment, and yet

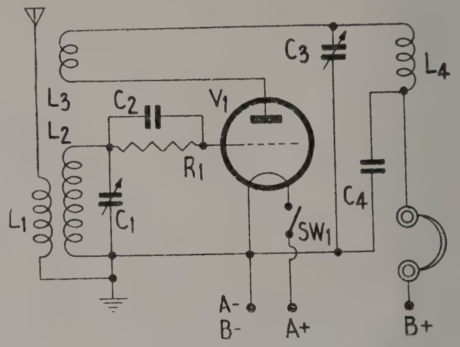


Fig. 28.

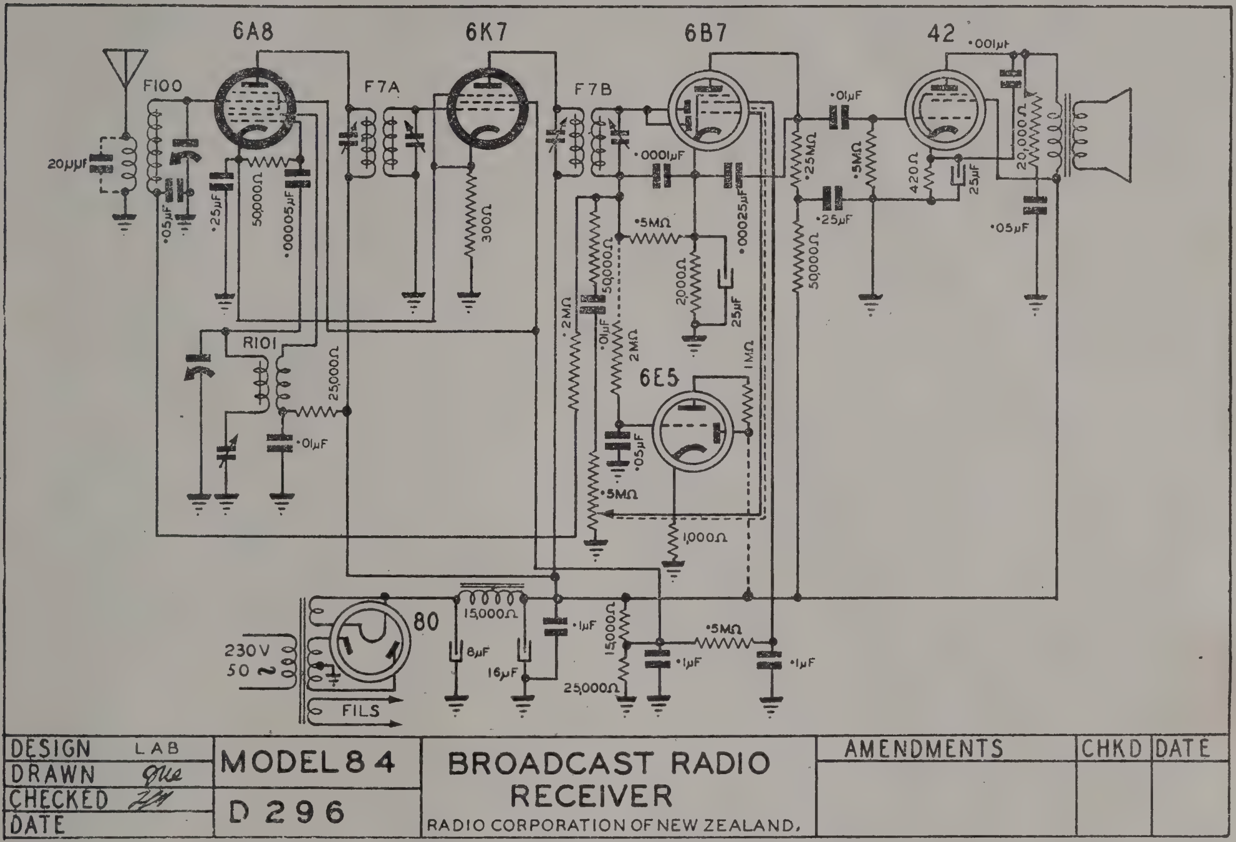
it is not a commercial proposition because it is tricky to adjust. Just what is meant by this, you will see when you first come to tuning in distant stations and separating them from one another when they are very close together on the dial.

TUNING A STATION

Next, the aerial can be connected, and our first listening done. First of all, turn the reaction control right back, because the first station we are going to listen to is one of our local ones. Now, if the tuning control is turned, you will find that the local stations come in hardly any louder than they did on the crystal set or on the set using the diode detector. This is because, without any feedback, the set is virtually the same as the latter. Now turn C_3 up a bit and swing the tuning dial round again. This time you will notice that the stations are still there, but that they come in a bit louder than they did before. Turn up the reaction control a little further and swing the tuning dial again. This time the station will be louder still. At the same time, if you observe carefully, you will find that not only is the signal louder, but also it occupies less space on the tuning dial. In other words, the set is now much more selective than it was before. Now, continue the process just described until, when the tuning dial is turned past a station the set makes a squeal. This squeal indicates that the set is oscillating. Now, for proper reception of any station, the reaction control must not be turned so far up that the squeal is heard when the set is tuned. This is self-evident, in a way, because the squeal does not altogether assist in the enjoyment of the music or the understanding of the speech! It will be noticed, too, that when a strong local station is tuned in, it can cause the set to stop oscillating, with the result that the squeal is heard only at the "edge" of the signal,

FOR THE SERVICEMAN

COLUMBUS MODEL 84.—This circuit requires no special alignment instructions, except to note that the I.F.'s are both 456 kc/sec.



as it were, and not when it is properly tuned. This kind of operation is not to be recommended for listening to locals, however, since the output of the set is almost always distorted when the set is tuned in this way.

The correct setting for local stations is best found by placing the reaction control well below where the set is known to oscillate, and then tuning them in with the tuning condenser.

TUNING DISTANT STATIONS

This scheme works quite well for locals, and other signals which may be very strong, but is no good at all for weak stations, which would hardly ever be heard if tuning were always done like that. This is because the signals from these stations are so small that, unless the set is in a very sensitive state, they will not be heard. Now, it would be a very difficult matter to adjust the tuning and reaction controls simultaneously, in such a way that the set is always in its most sensitive condition. This would make distant signals very hard to pick up, but the process of finding them is made very easy by the very squeal which we found was so annoying when listening to strong, easily found stations.

First of all, the reaction control is turned carefully until the characteristic rushing sound is heard, indicating oscillation. Now, the tuning condenser is turned very slowly. As the tuning passes through a station's signal, a whistle is heard, starting at a high pitch, descending to a low "growl," and then disappearing, momentarily, to commence again at a low pitch, which rises as the condenser is kept moving, until it finally disappears. This whistle serves as a very useful indication that the signal is present, and also, as we shall see, as an indication for finding the correct tuning. To tune in the station once the whistle has been found, all that is necessary is to set the tuning condenser as closely as possible to the point where the whistle disappears. Then, to complete the process, the tuning condenser is left untouched, and the reaction condenser is backed off, very carefully, until the whistle disappears and the station is heard. The tuning process takes a long time to describe, but only a few seconds to do, in practice. While it is being done, you will notice that as soon as the reaction control is touched, after the tuning has been set, the whistle reappears. This is because there is a slight amount of interaction be-

tween the two controls. That is to say, a movement of the reaction condenser affects slightly the frequency to which the set is tuned. We mention this because the effect makes it necessary to re-adjust the tuning very slightly **after** the reaction has been backed off, as described above.

It is for this reason, too, that the reaction must be set only to the point where the set is **just** oscillating, and not past it. If this were done, it is possible for the tuning to alter so much when the reaction is backed off, and the set no longer oscillates, that the station you are trying to tune in is lost, and perhaps another, quite close to it in frequency, is tuned in instead. These finer points are not so difficult to cope with when the set tunes to the broadcast band, as does this one, but assume major importance if the set is constructed to tune in shortwave stations. Enough has now been said for the beginner to be able to find his own way about tuning his set, and we can do no more than allow him to get in some practice, after which he will soon wonder what all the talk of difficulty was about!

BROADCAST AND SHORTWAVE

The next thing we must consider is the question of the difference between broadcast and shortwave stations. In the first place, is there any difference? There is, but really this is very small. Because practically all radio books (including ourselves) write about shortwaves and shortwave sets as something quite apart from broadcast ones, most beginners get the idea that there is a vast difference between them, but this is not strictly the case. **The only difference is one of frequency.** You will remember, when we were talking about alternating electric currents, we said that there is really no difference between the current with which we are supplied in our houses and the currents generated by radio stations, except in their frequencies. The former alternates at the slow rate, by comparison, of 50 times a second, while a broadcast station makes A.C. that alternates at rates varying from 500,000 to 1,500,000 times a second. These rates are so fast that we speak, for convenience, in terms of kilocycles per second instead of cycles per second. One kilocycle per second means exactly the same as 1000 cycles per second, so that the two examples given above would be called 500 kilocycles per second and 1500 kilocycles per second respectively. They are usually written as 500 kc./sec., for short. Now there is almost no limit to the frequency at which alternating currents can be made, so that we often run into the mention of frequencies much higher than these. When this happens, even kilocycles per second become too small a unit, and we have recourse to an even larger unit, megacycles per second. This is written as Mc./sec., for short, or sometimes mc./sec. One mc./sec. is the same thing as 1000 kc./sec., so that the frequency of 1,500,000 cycles per second can also be called either 1500 kc/sec. or 1.5 mc./sec., just as we please.

Now, the terms "long" and "short" are purely relative. That is to say, we can, if we like, call a mile a long distance, in which case an inch would be a very short one. At the same time, however, 10,000 miles would be a very long distance. If, though, we happened to be interested in distances such as that from the earth to the sun, 10,000 miles would be a very short distance indeed. All these distances we have been discussing are the same sort of thing, namely, measures of length, but at the same

time they are very different, in that an inch can be measured with a ruler, whereas the distance between the earth and the sun cannot. Well, the difference between short, medium, and long waves in radio is not one of KIND, but only of SIZE. At this point, the reader will probably have been struck by the fact that we have been talking partly about frequencies and partly about wavelengths. This is really a little inconsistent, because so far we have not said whether there is any connection at all between wavelength and frequency. As it happens, there is, and it is time that any misunderstanding was cleared up.

The relationship between wavelength and frequency is a very simple one that can be expressed numerically, as we shall see shortly, but first of all it is necessary to explain how it is that the two terms are more or less interchangeable. The term "wavelength" has been used since the very early days of radio, because of the fact stated earlier in this course, that when radio currents have escaped from the wires that carry them and are therefore said to be radiated, they may be likened in many ways to waves on the surface of a sheet of water. Water waves can be described completely if two things about them are known. The first of these is the wavelength, or the distance between successive peaks or troughs, and the second is the speed or velocity with which the waves travel. Now, if we imagine some waves in water passing a fixed point, then the number of waves which pass this point in one second must obviously depend upon both of these things. Also, a little thought will show that if we know both the wavelength and the speed of the waves as they travel through the water, it must be possible to work out how many waves pass the fixed point each second. For example, suppose that the distance between the wave-troughs is two feet, and also that they are moving at a speed of six feet per second, then the number of waves passing in one second must be $6 \div 2 = 3$.

Now, the number of waves passing the fixed point in each second can be called the **FREQUENCY** of the waves. Expressed as a simple formula, we have it that the connection between wavelength and frequency, when we are talking about water-waves, is:

$$\lambda = \frac{V}{f}$$

where V is the velocity of the waves in feet per second. and f is the frequency in waves per second, or, since these waves repeat themselves just as electric waves of current or voltage do, in cycles per second. The Greek letter λ is always used to denote wavelength, whatever units this is measured in.

Now, exactly the same relationship exists between the wavelength, velocity, and frequency of radio waves. With them, though, the velocity is very great indeed. It is exactly the same in value as the speed with which light travels, namely, 186,000 MILES per second. Fortunately, this speed is fixed. That is, it always has this value, as long as the waves are travelling through free space; because of this, we do not need to find out the velocity every time we want to find out what wavelength a particular frequency corresponds to, or vice versa. Thus, the formula contains only V and f, so that the sums mentioned a moment ago can be worked out quite easily. Now, in radio we usually give wavelengths in metres, and not in miles, so that the figure for velocity used in the formula is that expressing the speed in metres per second, and not miles per second. At the same time, the wavelength is measured in metres. Thus the formula becomes:—

$$\lambda = \frac{300,000}{f} \text{ metres}$$

where f is in kc./sec., or

$$\lambda = \frac{300}{f} \text{ metres}$$

where f is in mc./sec.

As an example, take the frequency of 1000 kc./sec. If this is substituted in the formula we get

$$\lambda = \frac{300,000}{1000} \text{ 300 metres}$$

Similarly, if we take 1500 kc./sec., we have

$$\lambda = \frac{300,000}{1500} \text{ 200 metres}$$

Now, to get back to our original subject of the difference between broadcast and shortwaves, we see that broadcast stations use comparatively long wavelengths, or, which is the same thing, low frequencies, while shortwave stations use shorter wavelengths, or higher frequencies.

You will remember that the part of our sets so far which determines to what wavelength or frequency the set is sensitive, is the tuned circuit, made up of a coil and a variable condenser in parallel. Also, in order to tune to different stations on the band, we vary the capacity of the condenser. From these facts it can be seen that the size of the condenser helps to determine the frequency to which the circuit is tuned. So does the size of the coil, or, properly speaking, its inductance. That is why we were careful to wind the coil with a specified number of turns, on a particular size of former. If we want to make a set which will tune to other frequencies than are covered by the broadcast band, all we have to do is to alter the size of both coil and condenser. The next point which arises is, "Exactly what effect on the frequency is made by increasing or decreasing the inductance of the coil and the capacity of the condenser?"

This is really two separate questions, and we will answer both of them without any attempt at proof.

IF EITHER THE CAPACITY OR THE INDUCTANCE IN THE TUNED CIRCUIT IS MADE SMALLER, THE FREQUENCY BECOMES HIGHER. This is easily seen as far as the condenser is concerned, simply by noting at what part of the dial stations of known frequency are received. If this question is examined, it will be found that the higher the frequency of a station, the further out are the plates of the condenser, or, in other words, the smaller is the capacity actually in use.

(To be continued.)

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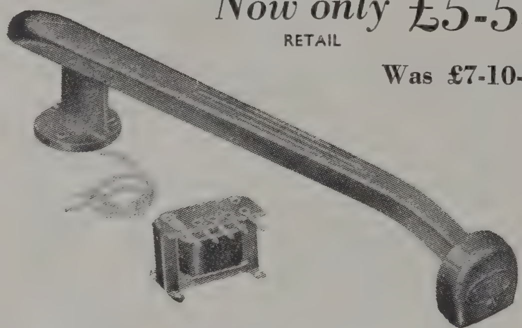

★ ★ ★

With our last shipment came the good news of this amazing price reduction. Due to the wide public acceptance of this remarkable reproducer it is now being mass produced—and is thus the lowest cost high-fidelity pick-up offering. Get the best from those favourite records.

★ ★ ★

Response, as certified by an N.B.S. Recording Contractors, is as follows:—

From 250 to 8000 C.P.S.	± ½ db.
At 150 C.P.S.	+1.5 db.
At 100 C.P.S.	0 db.
At 50 C.P.S.	— 2 db.
At 10 K.C.	+ 3 db.
At 12 K.C.	— 3 db.

The above gives average output from constant input.

Average recordings attenuate approx. 6 db. per octave below 500 C.P.S. Therefore your amplifier needs bass compensation as with all moving-coil and other high-fidelity pick-ups. For use with an ordinary radio, use our special bass boost.

Voice-coil impedance .... 2 ohms

Output from average recordings .12 to .2 volts R.M.S.

Output impedance of transformer .... 50,000 ohms

No Scratch — No Pre-amp. — Lightweight — No Scratch Filter necessary.

SPECIAL BASS-BOOST

For giving correct compensation for drop in recording levels at the bass end, we now offer the "Sonophone" Bass Boost. Simply lift power tube of radio, plug in adaptor, and re-insert power tube on top. The Bass-boost is small enough to tuck inside the cabinet. State type number of power tube in your set.

Cost of Pick-up, complete with the Bass-boost £8/8/-

Gain at 30 C.P.S. .... 37 db.

Gain at 50 C.P.S. .... 27 db.

Size—7⅛ in. x 3½ in. x 1⅞ in. overall—completely enclosed.

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Please forward me........S.E.I. High-fidelity Pick-ups with/without Bass-boost. Output tube for bass-boost is........ In enclose £ in payment. Please charge to our account (regular dealers only).

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Signed........

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....

PREDICTIONS FOR THE WORKING OF LONG-RANGE RADIO CIRCUITS ON AMATEUR FREQUENCIES

MARCH, 1948

These frequencies are based on world charts of Maximum Usable Frequencies, prepared and issued by the Australian Radio Propagation Committee and supplied to "Radio and Electronics" by courtesy of this body and the New Zealand Department of Scientific and Industrial Research.

Contrary to normal commercial practice in the use of ionospheric predictions, the times given are derived from the Maximum Usable Frequencies, directly, and not from Optimum Working Frequencies, which are 15 per cent. lower.

The circuits are considered workable (a) if the band in question is below the M.U.F. at the time considered, and (b) if the said band is not lower than 65 per cent. of the M.U.F. If (b) is not satisfied, communication is unlikely, not because the frequency is not reflected by the ionosphere, but because the power available to amateurs is too low to overcome absorption in the ionosphere under these conditions.

Where the word "doubtful" appears in the tables, it indicates that between the times so labelled, the band is a little higher than the M.U.F. There is thus a possibility of effective communication on days when the actual M.U.F. is only slightly higher than that predicted.

All circuits have been assumed to start in Wellington. This creates the possibility of some slight error for other starting points, but this is of minor importance only, and does not justify the multiplication of the work involved.

ENGLAND

	N.Z.D.S. Time
Wellington to Liverpool:	
(a) North Route.	
14 mc./sec.	1800 — 0930
30 mc./sec.	Nil
(b) South Route.	
14 mc./sec.	1700 — 1330
30 mc./sec.	Nil

U.S.A.

Wellington to New York:	
14 mc./sec.	24 hrs.
30 mc./sec.	0630 — 1230
Wellington to New Orleans:	
14 mc./sec.	24 hrs.
30 mc./sec.	0630 — 1500
Wellington to Washington:	
14 mc./sec.	0230 — 2330
30 mc./sec.	0700 — 1700
Wellington to San Diego:	
14 mc./sec.	24 hrs.
30 mc./sec.	0700 — 1600

CANAL ZONE AND SOUTH AMERICA

Wellington to Panama:	
14 mc./sec.	24 hrs.
30 mc./sec.	0630 — 1800
Wellington to Pernambuco:	
14 mc./sec.	24 hrs.
30 mc./sec.	0930 — 1200
	1200 — 1700 (doubtful)
Wellington to Buenos Aires:	
14 mc./sec.	24 hrs.
30 mc./sec.	0930 — 1200

AFRICA

Wellington to Dakar (South Route):	
14 mc./sec.	24 hrs.
30 mc./sec.	0930 — 1530 (doubtful)
(North Route)	
14 mc./sec.	24 hrs.
30 mc./sec.	1930 — 2030
Wellington to Capetown:	
14 mc./sec.	24 hrs.
30 mc./sec.	1800 — 1900
Wellington to Aden:	
14 mc./sec.	24 hrs.
30 mc./sec.	1430 — 2130

INDIA

Wellington to Karachi:	
14 mc./sec.	24 hrs.
30 mc./sec.	1330 — 2100
Wellington to Colombo:	
14 mc./sec.	24 hrs.
30 mc./sec.	1230 — 2100
Wellington to Calcutta:	
14 mc./sec.	24 hrs.
30 mc./sec.	1130 — 2100

ASIA

Wellington to Hong Kong:	
14 mc./sec.	24 hrs.
30 mc./sec.	1030 — 2030
Wellington to Singapore:	
14 mc./sec.	24 hrs.
30 mc./sec.	1100 — 2100

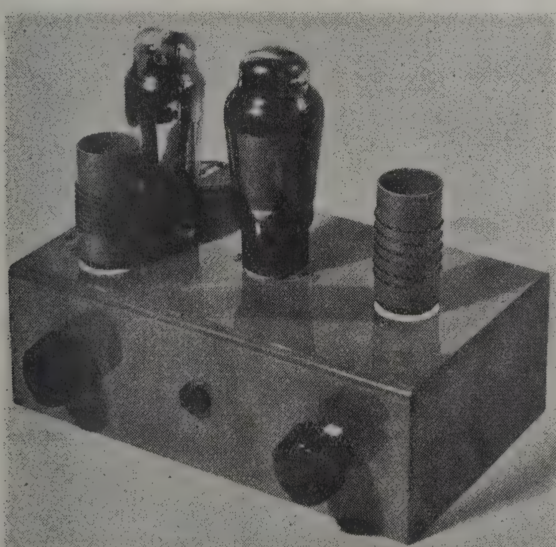
The PHILIPS Experimenter

Inserted by Philips Electrical Industries of New Zealand.

No. 5: A TWO-TUBE EXCITER FOR FOUR AMATEUR BANDS

In amateur circles, the question of exciters for multi-band working is a vexed one, from several points of view. In the first place, one has to have output to excite the final on four harmonically related bands, all of which must be controlled as to frequency with a high standard of accuracy. Thus, the first problem is to decide whether to use a crystal oscillator or a V.F.O., with its attendant difficulties in obtaining good enough stability. Next comes the decision between band-switching and plug-in coils, or whether a combination of both is to be used. Then, and perhaps worst of all, is the question of a suitable tube line-up. Are there to be entirely separate doublers for each band, or are the doublers to be made more economical by switching them in successively, as required? This and many other problems have to be answered even before an attempt is made to draw out a suitable circuit. One of the characteristics of all-band exciters that is most often objected to, and with some reason, too, is the complication and large number of tubes one is liable to end up with, simply for the pleasure of having a single, unified piece of equipment.

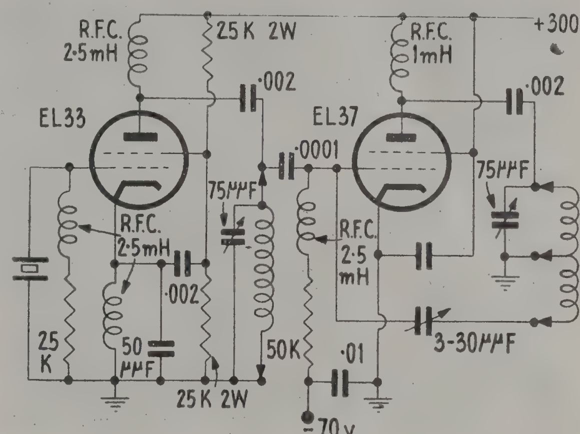
It is to show how Philips tubes may be used to solve all these difficulties (at least in one of the many possible ways) that this exciter has been designed. By making use of two Philips valves, both



of which have extremely high mutual conductance, a unit has been evolved which employs a total of only two tubes, but which can give substantial output on all bands, from 80 to 10 metres, inclusive, using a crystal at 80 metres in every case.

CIRCUIT DESCRIPTION

The oscillator is an EL33, in which the control-grid, screen, and cathode act as a triode earthed-plate oscillator, and the plate circuit acts either as a straight amplifier, a doubler, or a quadrupler. Thus the EL33 produces output on either 80, 40, or 20 metres, according to what coil is plugged into the plate circuit. By now it will be apparent that the



exciter used plug-in coils, but there seems to be little reason why coil-switching should not be employed if desired. An advantage of the plug-in system is that fewer coils need be constructed. The multiplier is an EL37, which is neutralized to act as a straight-through amplifier on 80 metres, and acts as a doubler to give output on 40, 20, and 10 metres.

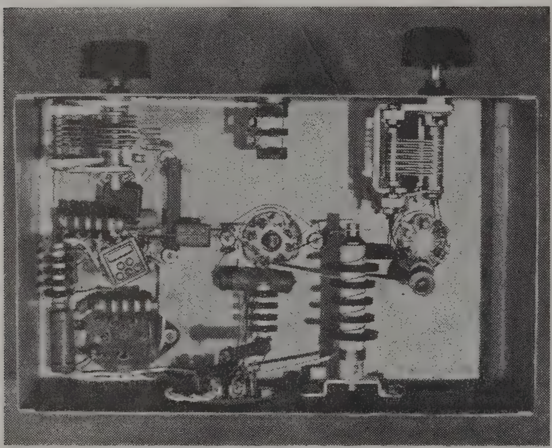
The R.F. choke in the cathode lead of the oscillator provides regeneration, and assists in giving the tube considerable output when the plate circuit is tuned to the fourth harmonic of the crystal. The purpose of the 50 mmfd. condenser in parallel with the choke is to ensure that the impedance at the cathode is much lower to the crystal harmonics than to the fundamental.

Shunt feed has been used for the tuned load circuit so as to remove H.T. from the coil, and prevent the possibility of shocks occurring should the power be accidentally left on while coils are being changed. Similar chokes of the small four-pin variety were used at both oscillator plate and EL37 grid without any trouble due to stray resonances or parasitics.

The EL37 circuit is quite standard except for the manner in which provision is made for neutralizing on one band only. The latter is accomplished by the use of a neutralizing coil which is not part of the output tank circuit. This avoids the necessity for having a split-stator tuning condenser, only useful on the one band, and also has the advantage of making the neutralizing adjustment much easier to perform. It will be noticed that the neutralizing coil has only 22 turns. This means that the neutralizing condenser need not have a capacity so small as to be comparable to the grid-plate capacity of the valve. In fact, a 3–30 mmfd. Philips trimmer is used as the neutra-

lizing condenser, and the correct setting in our case was at about half capacity. This method is probably the best one for neutralizing beam-tetrodes or pentodes, where over-neutralization is difficult to avoid if the more usual circuits are used. When one of the higher frequency coils is plugged into the final tank circuit, the neutralizing condenser is left floating, with no detrimental effect at all.

It will be noted that the EL37 is biased by a combination of fixed and grid-leak bias. There are two reasons for this. First of all, when fixed bias only was used, self-oscillation of the whole system occurred on some bands. This appeared to be due to the use of exactly similar chokes in the oscillator



Underneath view of the exciter. The oscillator is at the left of the chassis, which measures 9½ in. x 5½ in. x 3 in. The keying jack in the centre of the chassis front is not shown in the circuit diagram, but if included it should be connected in the oscillator cathode, between the lower end of the cathode choke and earth.

plate and EL37 grid circuits, since the substitution of part of the fixed bias by the 50k. grid-leak, as shown, cured the trouble completely. In addition, not everyone has a power pack for biasing purposes, and to build one requires considerable care in achieving good regulation. However, 67.5v. of dry battery is easily enough obtained, and gives perfect bias regulation. Of course, if a suitable bias pack is on hand, there is no reason why it should not be used.

The second reason for using the present biasing system is that by its means all possibility of damage to the EL37 through failure of the oscillator is prevented. The 70v. of fixed bias is much more than is needed to bias the multiplier to cut-off, so that in the event of oscillator failure the plate current of the second tube simply drops to zero. The total bias on the EL37 when operating is more than 200v., which makes for much greater efficiency when it is doubling and quadrupling. THE PROPER GRID CURRENT OF 3ma. IS READILY OBTAINED ON ALL BANDS. There was found to be no advantage in driving the EL37 to a higher grid current than this, since doing so did not increase the power output on any of the bands, and it is advisable to keep the grid dissipation in the tube within reasonable limits. There is also nothing to be gained by using an H.T. voltage higher than the 300v. specified, as the output on all bands exceeds 5 watts, and is nearer 10 than 5 on all bands other than 10 metres.

COIL SPECIFICATIONS

Coil winding data for the various bands are as follows:—

The coils required are:

Band	Qty.
80m.	2*
40m.	1
20m.	1
10m.	1

*One with neutralizing coil.

The coils required when the bands are in use are:

Band	Osc. Plate	EL37 Plate
80m.	80	80*
40m.	80	40
20m.	40	20
10m.	20	10

From the above, it can be seen that only on 80m. are two coils needed that are tuned to the same frequency. Also, on all other bands only one each is required because of the fact that the plate tuning condensers for both tubes are identical. Thus, when the above table calls for a 40m. or 20m. coil, the same one can be used, irrespective of whether it is to be in the oscillator or the EL37 plate. In short, although two coils are used for each band, only five are needed instead of eight, Winding data are given below:—

Coil	Wire	Turns
80m.	20 S.W.G. en.	35, close-wound
80m.*	Same as above, with neut. coil consisting of 22 turns of 26 S.W.G. en. close-wound	
40m.	20 S.W.G.	17, close-wound
20m.	20 S.W.G. en.	8½, spaced by wire diam.
10m.	20 S.W.G. en.	5½, spaced by wire diam.

*With neut. coil.

CONSTRUCTION

The type of construction used in our original model can be seen from the photographs to be quite conventional, and needs no great description. A point to note is that in the oscillator circuit, where three 2.5 mh. chokes are used and must necessarily be placed somewhat close together, these chokes are placed mutually at right-angles. This helps to prevent undesired coupling between them, and therefore to eliminate some of the possible troubles mentioned earlier. The midget tuning condensers are mounted under the chassis, thus providing short leads to the coil sockets. The latter are of ceramic construction, to minimize losses, as are the valve and crystal sockets. The whole is laid out in a straightforward manner following the way the circuit progresses. It will be noted that no output coupling arrangements have been shown on the circuit, but this has been done purposely, as the type of output coupling used is really a matter for the individual user to decide for himself. However, we prefer a low-impedance link where the exciter is to remain a separate unit from the high power stage. The links can be permanently wound on the formers, and will cause no complications if they are left floating when the coil is used in the oscillator plate position.

TUNING AND ADJUSTMENT

Very little need be said about this, as the process is almost ridiculously simple. All that is necessary in the first instance is a meter reading 0–10 ma. or so, with which to read the EL37 grid-current, and

(Concluded on page 48.)

OUR GOSSIP COLUMN

It has been announced that Mr. Clifton Lewis has been appointed Managing Director of Radio (1936) Ltd. on the retirement of Mr. W. J. Truscott. We join the radio industry in extending our heartiest congratulations to Cliff on his "taking the wheel" at Radio Ltd.

* * *

Ralph Slade, who has recently returned from a visit to Auckland, tells us that a very good session was held at the "4 x 2" Club to celebrate the occasion of Mr. Clifton Lewis being appointed to the position of Managing Director of Radio (1936) Ltd. All members of the radio industry were present — a proven fact for, we understand, there was no change from a £1. Jean Parker, the Club's charming hostess, produced a banquet "fit for a king," and behind the organisation we suspect the guiding hand of Fred Noad.

* * *

The various changes going on at Radio Ltd. must have put everyone on their mettle. Whatever the cause the fact remains that two days after the above party they met their old rivals Photo Engravers Ltd. at Titirangi Golf Links and took several strips off them. In the contest for the teams trophy, the Ryder Cup (a tin disc suitably inscribed), Radio Ltd. carried the day against strong competition. In individual competitions W. J. Truscott and Clifton Lewis won the four ball best ball bogey. The best single bogey was won by Gordon Truscott. Doug. Lamb brought home the bacon in the Stableford Trophy and John Drought won the best nett medal. Apart from these untoward happenings we are told that everyone appeared to behave themselves. We are now seeking unbiassed confirmation of this report.

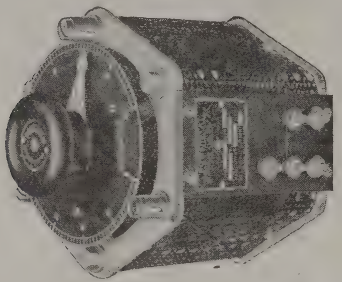
From the beginning of this year active management of Radio (1936) Ltd. was relinquished by Mr. W. J. Truscott, who was succeeded by Mr. D. T. Clifton Lewis as Managing Director. Mr. Truscott becomes Chairman of Directors.

It is 25 years since Mr. Truscott assumed the management of Radio Ltd. and to mark the occasion a gathering was held recently to express the goodwill of the staff. As a mark of appreciation Mr. Truscott was presented with a magnificent custom built radio housed in a very attractive limed oak cabinet of special design. Afterwards an informal "get-together" party was held and an extremely enjoyable time was had by all around the piano till a late hour.

"Radio and Electrical Services" put on a good show at the recent Inventors Exhibition in the Auckland Town Hall. Besides having one of the biggest single displays in which was featured their new speaker system which has been advertised in "Radio and Electronics," they also arranged a novel intercommunication system throughout the hall which was used by hundreds of people to talk to their friends in other parts of the exhibition. Great interest was taken in the new speaker system they have designed, and in view of this we have arranged for articles on it to appear in forthcoming issues of this journal. (Continued on page 48.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

POWERSTAT VARIABLE VOLTAGE TRANSFORMERS



There seems to be little doubt that, during the coming year, New Zealand must again face electric power restrictions with their accompanying inconveniences, particularly that experienced by electronic engineers, namely, the low voltage which usually accompanies heavily loaded power lines.

However, the Swan Electric Co., Ltd., advises that it now has available supplies of the "Powerstat" variable voltage transformers. These instruments are of untold value to the radio and electronic engineers who, to obtain best and most efficient results, must have constant voltages not only for the instrument being worked, but also for the test instruments essential to the craft.

Unfortunately, in this column it is not possible to deal at length with the wide range of "Powerstats" available. These range from small 2.5 k.v.a. sizes up to the large type capable of outputs of up to 7.5 k.v.a. The efficiency of the "Powerstat" is indicated by type 1226 illustrated. The input is 230 volts, output 0-270 volts 9.0 amperes, 2.4 k.v.a. on 230-volt line. There is **negligible variation** in output voltage from no load to full load current.

Full details of "Powerstats" may be obtained from the Swan Electric Co., Ltd., Auckland, Wellington, and Christchurch.

"RADIO AND ELECTRONICS"

Current and back numbers of "Radio and Electronics" are available from:

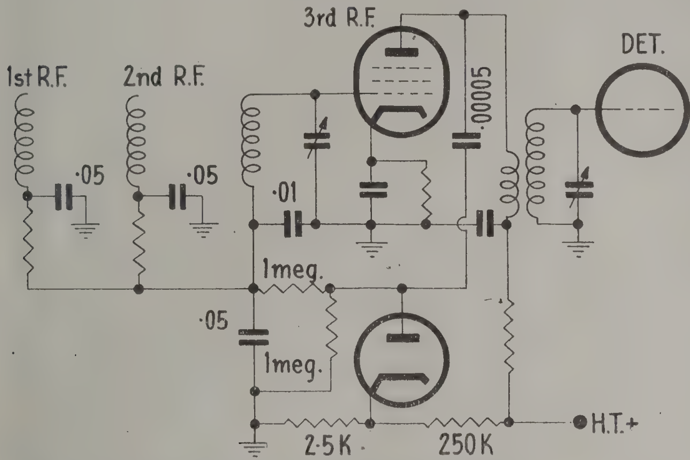
Te Aro Book Depot, Wellington.
S.O.S. Radio Ltd., Auckland.
Tricity House, Christchurch.

QUESTIONS and ANSWERS

ADDING A.V.C. TO A T.R.F.

W.S., Auckland, writes as follows:—

"I have a good quality amplifier and use a separate tuning unit which is a T.R.F. using three stages of 6K7 R.F. amplifiers, followed by a 6C5 as an infinite impedance detector. This outfit works very well except for fading, which is quite severe. I have tried several circuits in an attempt to provide A.V.C., but without much success. Could you give me a circuit that would be satisfactory in this respect?"



As W.S. states, it is not easy to get good A.V.C. action with a T.R.F. receiver. This is mainly because the average T.R.F. has rather less sensitivity than a superhet. using the same number of valves. However, in the case in question, there should be enough R.F. gain for a reasonably good A.V.C. characteristic to be attained. The accompanying circuit shows how delayed A.V.C. can be added to W.S.'s set. The rectifier can be a 6H6, with sections in parallel, or, if desired it can use any small medium-mu triode with the plate and grid tied and used as the diode plate. Approximately 2.5v. delay is provided by means of the voltage divider to which the A.V.C. rectifier cathode is tapped, this preventing loss of amplification at low signal levels, and allowing the set to have its full sensitivity until the signal voltage at the plate of the 3rd R.F. stage reaches 2.5v. peak. The feed to the rectifier is taken from the plate rather than from the detector grid because the signal voltage is actually higher at the R.F. plate than at the following tuned circuit. The A.V.C. action is thereby improved. A point that may seem peculiar is the use of two bypass condensers at the output of the A.V.C. filter. One of these, a 0.01 mfd., should be wired in right at the coil, and should be earthed to the same place as the wiper of the condenser gang. This prevents R.F. currents from having to flow through part of the chassis. The other, of 0.05 mfd., should be wired right at the 1 meg. filter resistor to prevent the A.V.C. lead to the 3rd stage from picking up R.F. from other parts of the circuit, and possibly causing instability. If the lead referred to is very short, due to the layout of the set, the 0.01 mfd. condenser can be omitted.

THE CATHODE-COUPLED TWIN-TRIODE R.F. AMPLIFIER

R.B., Petone, writes:—

"Would you please answer the following questions relative to the cathode-coupled twin-triode R.F. amplifier circuit:—

"(1) Can a 6F8-G be used in place of a 6SN7 in this circuit, and can the same tube be used as a combined oscillator and infinite impedance mixer?

"(2) Do you suggest iron or air-cored coils for the aerial and R.F. tuned circuits?

"(3) I wish to use after the triode R.F. and mixer stages, the 'Experimental Two-stage I.F. Amplifier' described in your January, 1947, issue. Would it be best to use (a) air-cored I.F. transformers, (b) iron-cored ditto, or (c) a combination of both?"

Taking these questions in order:—

(1) The 6F8 can be used in both of the circuits referred to, in place of the 6SN7, without any circuit alterations, since except for slight differences in inter-electrode capacities, the two types are identical electrically. The important difference is that the 6F8-G has one of the triode's grids brought out to a top-cap, while the 6SN7 is single-ended. Thus, as far as mechanical layout is concerned, the two types are complementary. Where the top-cap grid is better from the point of view of the lead arrangement, the 6F8-G may be used, but if a single-ended tube gives a better layout, the 6SN7 should be chosen. The 6C8-G, however, cannot be used as a direct replacement for either of

these tubes, as it has a much lower mutual conductance. It would probably not give such good results in the R.F. amplifier circuit, but could possibly be used as the oscillator-mixer quite well.

(2) There is no reason why iron-cored coils should not be used in the aerial and R.F. circuits. They should give rather higher gain than air-cored ones, and so necessitate more care in setting out the circuit so that feedback and oscillation are avoided.

(3) In a two-stage I.F. amplifier, the greatest difficulty is to make it perfectly stable. While there is nothing against using iron-cored transformers throughout if the amplifier can be made to "sit down" properly, it is safer to use air-cored ones, as the gain per stage will be somewhat less, and stable operation will be easier to obtain. Nor is there appreciable disadvantage in doing so, because a two-stage amplifier, even with air-cored transformers, will have more actual gain than can be used, and the difference in selectivity, though measurable, will be negligible in practice. There seems nothing to be gained, therefore, by employing a mixture of iron and air-cored transformers.

* * *

THE RADEL DUAL-WAVE FIVE

T.E.C., New Plymouth, writes with information that he is experiencing trouble with instability on the short-wave band of a "Radel Dual-wave Five" which he has built. The fault shows up as an audio beat-note on all short-wave stations, which varys in pitch as the tuning is varied.

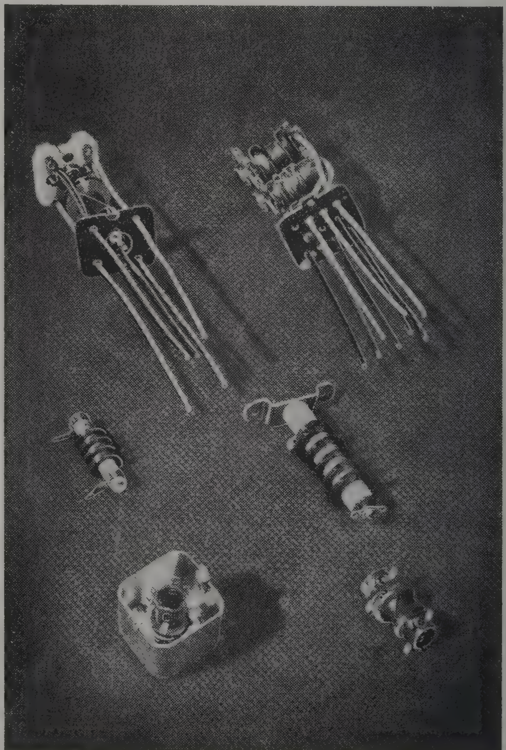
From this description, the trouble appears to be due to oscillation in the I.F. amplifier. There is not much that can be said from the brief details available, but the following points may be of assistance.

First, the gang condenser should be properly earthed. This means that the wiper which is intended to make the proper earth connection for the gang should be earthed to the same point as the ground return of the mixer grid tuned circuit. This is important, as can be seen from the fact that when manufacturers turn out coil units, they are careful to earth the return leads of all coils belonging to the same stage to a single point on the chassis of the unit, and then they provide a piece of heavy braid from the same place, with instructions that this braid is to be connected by as direct a route as possible to the wiper of the gang condenser.

Secondly, it is a help if all grounds in the I.F. stage are taken to the one point on the chassis, which can be the "shell" terminal of the valve socket.

A third point is that the trouble may be due to I.F. getting into the audio amplifier, and feeding back from there to the I.F. stage grid. This can be tested by connecting a fairly large condenser across the output transformer primary. If this cures the trouble, the smallest condenser is found, by trial, that will be effective in stopping the oscillation, and yet does not affect the audio quality by cutting the high-frequency response. When this value has been decided upon, the condenser is wired in permanently.

A further precaution is to see that the aerial lead does not run too close to the I.F. input lead. This can cause both I.F. and R.F. instability.



A WORLD WIDE COMPETITION OF INTEREST TO ALL RADIO AMATEURS

An Opportunity to Win

The Eddystone "640" Communications Receiver has been designed and produced by professional engineers, with long and extensive experience, and well versed in amateur radio technique. The "640" not only possesses a first-class electrical performance but is also a sound engineering job, built "to take it" in any climate.

The "640" is well known to British amateurs, many of whom are with its aid, working more "DX" than ever before.

To obtain overseas publicity for the "640" Receiver, and to give overseas Radio Amateurs and Shortwave Listeners an opportunity of competing for one, we have decided to present, free of charge, a new Eddystone "640" Receiver to the writer of the best article on one of the three following subjects:—

(i) How do you visualise the application of the new Micro-wave Channels shortly to be allocated to radio amateurs?

(ii) It is evident that Band Planning will be essential if the most is to be made of the Amateur Bands. What proposals have you to make in this connection?

(iii) What are your views on the subject of the relative merits of British and American Communications Equipment? (We wish to make it clear that articles on this subject should be written without prejudice.)

Choose one of these—the one you feel you can write about easiest—and write an article about it, running to not more than 1,500 words. To the writer of the best essay, an Eddystone "640" Receiver will be presented FREE. When judging the work, points will be awarded not only on literary style but also on clarity, force of argument, constructiveness, and other similar factors. All, therefore, have an equal chance.

The following have kindly consented to act as judges:

Mr. John Clarricoats, General Secretary, R.S.G.B.
Mr. Austin Forsyth, O.B.E. Editor "Short Wave Magazine."
Mr. Geoffrey Parr, M.I.E.E., Editor "Electronic Engineering."

COMPETITION RULES

1. Write an article of not more than 1,500 words on any of the specified subjects.
2. Entries to be preferably typed or, alternatively, written in ink, on one side of the paper only, with wide margins.
3. Entrant's name, full address, and occupation to be clearly shown on each entry.
4. Entries to be posted in sealed envelopes, marked "Competition" in top left-hand corner, to Stratton & Co., Ltd., Eddystone Works, Alvechurch Road, Birmingham 31, England.
5. Closing date for the Overseas Competition is 30th April, 1948.
6. The prizewinner will be notified by cable as soon as possible after the closing date.
7. The copyright of all entries is reserved by Stratton & Co., Ltd.
8. Competitors must be resident outside the United Kingdom.
9. It is a condition of entry that the judges' decision is final and legally binding. No correspondence can be entered into on the subject of the Competition.

Intending competitors may send their entries to the New Zealand Agents for Eddystone, Messrs. Arnold & Wright, Ltd., Levy Buildings, Wellington, or direct to Messrs. Stratton & Co., Ltd., England.

The closing date for the competition in New Zealand is the 15th April, 1948, and as stated above, the closing date in England is the 30th April, 1948.

"RADIO AND ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio Service Ltd., Queen St., Auckland.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

compensation by making the filter a component of the grid-leak. This is shown in Fig. 2, where an acceptor circuit is in parallel with a half-megohm resistor at the earthy end of a half-megohm volume control. The arrangement permits the filtering out of predetermined frequencies without materially affecting the volume level. A slight modification of this circuit is of interest, as it permits both treble and bass "boosting," while the volume control attenuates the middle frequencies, so that a good tonal balance results. The circuit is shown in Fig. 3, with practical values for components as used suc-

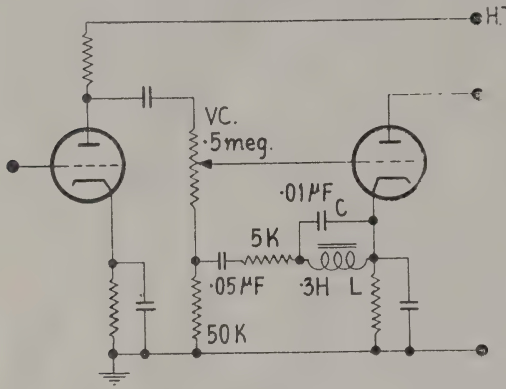


Fig. 3.

cessfully in one make of commercial receiver.

An objection to the resonant system is the extra cost of the inductances (apart from their bulk) and to the fact that the tuned circuits may be shock excited by transients into self-oscillations and so cause unwanted whistles. The system has been successfully used with gramophone amplifiers of the "high fidelity" type to compensate for the frequency limitations in the disc grooves, and will be referred to again later when dealing with this side of the question.

(2) Resistance-capacity Filters:

These are by far the most usual, because of their comparative simplicity and low cost of components. The simplest system, and perhaps the commonest, comprises a condenser and variable resistor in series connected between H.T. and output valve anode or between anode and earth, and must be familiar to everyone. Connected in this position, it has a marked effect on the volume level. It is better to connect such controls as early as possible in the L.F. section of the receiver where the signal amplitude is smallest, but with the ubiquitous D.D.T./power valve combination there is not very much choice, though it can be placed across the anode circuit of the D.D.T. before the coupling condenser.

Sometimes, especially with midgets, space does not permit the use of a variable resistance, and, as often as not, a compromise is made by connecting a cóndenser of suitable value across the primary of the output transformer to give a certain amount of top cut, and hence the effect of "bass boost." Considerable improvement can be easily made with a little thought and experiment if the following principles are obeyed. Fig. 4(A) shows the basic circuit for "bass boost," and Fig. 4(B) for "treble boost." Taking (A), at high audio frequencies the reactance of C is negligible, and the system boils down to a simple potential divider to reduce the treble amplification by the ratio

$$\frac{R_2}{R_1 + R_2}$$

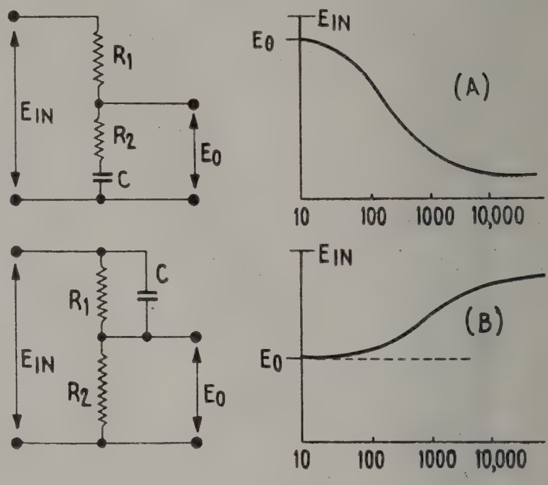


Fig. 4.

At low frequencies the reactance of C is not negligible, and the value of the potential divider approaches unity. The "boost" is thus given by the ratio

$$\frac{R_1 + R_2}{R_2}$$

The value of C decides the frequency at which "boost" begins, that is, when the reactance of C equals R_2. So that, if the "boost" is to begin at a frequency f, then

$$C = \frac{1}{2\pi f R_2}$$

The argument for the "treble boost" case is on similar lines, and the value of C can be calculated from the equation

$$C = \frac{1}{2\pi f R_1}$$

Supposing we want a rising characteristic after 5000 c/sec. and R_1 is 150,000 ohms with R_2 at 50,000 ohms, we find that

$$C = \frac{1}{2 \times 3.142 \times 5000 \times 150{,}000} = .0002 \text{ mfd. approx.}$$

Obviously, these two systems may be combined to give both bass and top cut relative to the middle frequencies, and this is shown in Fig. 5, in which suggested practical values have been given. In practice, of course, the actual values will be finally decided by trial and error to suit the optimum quality for the particular set.

We have mentioned above that it is usual to fit a fixed condenser/variable resistance system as a tone control. Some manufacturers vary this by using a fixed resistance with a bank of condensers selected by a single-pole two or three-way switch, or alternatively use a fixed condenser with a bank of resistors similarly switched. This gives tonal compensation by

arbitary steps, and is not as acoustically satisfactory as the more elastic variable resistance type.

(3) Frequency Feedback:

Negative feedback can be applied by feeding back voltage or current, as is well known, and simple circuits for both systems are given in Figs. 6 and 7. In Fig. 6, when the variable resistor is full "in," C_2 is virtually out of circuit, and the percentage of voltage fedback is approximately constant at all audio frequencies, as C_1 is of large value, say, .35 mfd. with R at 2 megohms. With R turned to minimum, C_2 is connected across it and the proportion of voltage fed back to the grid increases with frequency and so gives a bass "boost" effect. Fig. 7 is a current feedback circuit in which the output valve bias resistor is R_1, while R_2 gives a percentage of feedback current. When the potentiometer P is full "in," C_1 (of large value, say, .5 mfd.) is directly across R_1 and R_2, so that the feedback current is REDUCED as the FREQUENCY INCREASES, and so gives gain of the higher audio frequencies.

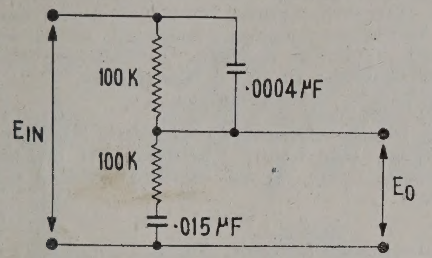


Fig. 5.

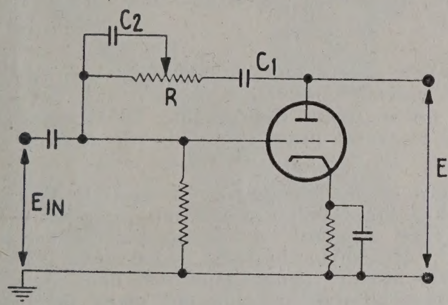


Fig. 6.

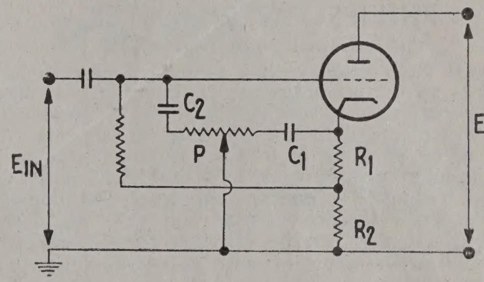


Fig. 7.

(Continued on next page.)

RADIO POSITION-FINDING SYSTEMS

(Continued from page 19.)

technical methods used. Mr. Strong modestly describes his suggestions as a preliminary reconnaissance. They will, however, arouse a great deal of interest; and will, we hope, lead to action along the lines he suggests.

HIGH QUALITY 6-VALVE RECEIVER

(Continued from page 15.)

and eight-inch speaker are used, the excellence of the reproduction is surprising, and the constructor who has gone to the trouble of following the circuit completely will be more than well repaid for his trouble.

PHILIPS EXPERIMENTER

(Continued from page 38.)

a 15-watt lamp fitted with a two or three-turn loop to act as an output indicator. If the coils have been made according to specifications, there should be no question of their not "hitting" the bands. All that has to be done is to tune the oscillator plate for maximum grid-current, and the EL37 plate for greatest output. Of course, one needs to be sure that the respective circuits are on their right frequencies, but this can be checked readily with the absorption wave-meter or with a grid-dip meter.

There are, no doubt, many modifications that individual builders will wish to make themselves, to suit their own specific needs, but there is little doubt that the arrangements given in this article can form the basis of one of the simplest and at the same time the most efficient all-band exciter systems yet presented for amateur-band use.

Next month, the "Experimenter" will feature a superhet. converter for 20, 10, and 6 metres, using some of the special Philips tubes described in the "Philips Experimenter" No. 4.

TONE CONTROL SYSTEMS

(Continued from page 47.)

With the potentiometer at the other extreme, C_2 is shunted across the input, and the high notes are bypassed proportionately to the increase in frequency, and hence gives top cut or bass "boost." The potentiometer P thus gives a balance type of tone control and is very smooth in operation.

(To be continued.)

CLASSIFIED ADVERTISEMENT

OUR GOSSIP COLUMN

(Continued from page 40.)

J. R. Robertson of New Zealand Industries was seen in Wellington recently looking very fit and full of life.

Whenever we check up on general activities for our Gossip Column we can always be sure that at the National Carbon Pty. Ltd. someone is either going to or coming from Australia. This month Charles Hart is in Sydney. Ron Greenwood has been in the South on a fishing expedition, so we suspect that Tom Jamieson and Rex Lulham are hosts at National Carbon's 10 and 3 "tea parties."

* * *

Norm Swann of the Swan Electric Co. has been in Australia since before Christmas. At the time of our going to Press, he was expected back at the end of January.

* * *

Our Technical Director, Doug Foster, B.Sc., has received information that he has been admitted as an Associate Member of the British Institute of Radio Engineers.

* * *

We believe that George Wooller has arrived back from an extended tour in U.S.A. It has not been possible for us to see George since he returned, but we hope to report more about his trip next month.

* * *

Al Webb of Webb's Radios Ltd. was in Wellington during the holidays. On one occasion when Charles Hart was entertaining him the conversation, as usual, drifted to business, whereupon Charles lapsed into moody silence. However, upon Al mentioning that he was bringing out many new ideas for the coming season, Charles immediately brightened, with the eveready question of "Does it use batteries?"

AN OMISSION RECTIFIED

In our November, 1947, issue we were unable to include the table promised in the article on the Response-Compensated 6L6 Amplifier. This table, it will be remembered, was to indicate the value of the feedback resistor R_{30}, for various loud-speaker voice-coil impedances. With our regrets for the delay in presenting this information, we print the table below.

VOICE-COIL IMPEDANCE	R_{30}
3 ohms	106 ohms
4 ,,	124 ,,
5 ,,	140 ,,
6 ,,	155 ,,
7 ,,	168 ,,
8 ,,	183 ,,
9 ,,	191 ,,
10 ,,	202 ,,
12 ,,	221 ,,
15 ,,	250 ,,
17.5 ,,	271 ,,
20 ,,	287 ,,
25 ,,	347 ,,
250 ,, (low impedance line)	1050 ,,
500 ,, (low impedance line)	1490 ,,

* * *

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